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RAILWAY SHOPS.

BY R. H. SOULE.

VI.

THE PASSENGER CAR REPAIR SHOP.

(Including the Paint Shop and the Transfer Table.)

Nearly all passenger car repair shops are of the transverse type, which generally admits of handling each car in and out of the shop as a unit, although a few such transverse shops are made wide enough to take two cars to each track, this arrangement being resorted to in order to secure compactness of layout, or to conform to some local condition or requirement. With two or more cars to the stall it is sure to happen that an unfinished car will frequently block a finished car, so that the capacity and output of the shop are unfavorably affected. With only a single car to the stall, maximum output may be obtained, but for a shop of given standing capacity the building must be longer and the average internal distances to be traversed by men must be greater. It is believed, however, that the single stall arrangement is generally to be preferred. Of the very few longitudinal shops in use, examples may be found at Altoona, Pa. (P. R. R.), McKee's Rocks, Pa. (P. & L. E.) and elsewhere. No known advantage attaches to the use of the longitudinal shop and layout conditions, and restrictions alone can account for it. Shops of the roundhouse form are used at Columbus Ohio (Penna. Lines), Roanoke, Va. (N. & W.) and Baltimore, Md. (B. & O.). Those at Columbus and Roanoke were built as freight car construction shops (for which they are very well adapted), and are only incidentally used for passenger car repairs; that at Baltimore, it is believed, is an old engine house, which was abandoned for road work. As neither the longitudinal nor the roundhouse forms are to be preferred to the transverse type for either the repair or the painting of passenger equipment cars, only the transverse type needs to be considered.

A typical and prevalent arrangement of passenger repair and paint shops places the two buildings on opposite sides of an intermediate transfer table and pit, and several such cases are listed in Table 11. Examinging this table, it appears that in general 20 ft. center to center is a sufficient spread for repair shop tracks, especially if there are no intermediate posts, so that a clear working space between tracks is guaranteed. It is noticed that Montreal and Readville, two new shops, have a spread of 24 ft.; but it is known that at Montreal many new passenger equipment cars are to be built, and construction requires more room than repairs, while Readville is a very wide shop (225 ft.), where posts to support the roof are a necessity. As regards span (for repair shops), it is evident that at Omaha, Burnside and Concord, two cars can be stood on each track, and at Readville three, but for shops to stand but one car on a track a span of 100 ft. seems liberal, although the proposed new shop of the Atchison, Topeka & Santa Fe at San Bernardino, Cal., is to be 110 ft. In advising a span of about 100 ft. it is assumed that space is thus obtained for car bodies and bench work only, the trucks being transferred to other stalls for heavy repairs, and moreover it is entirely possible that the evolution of shop design will justify a span greater than 100 ft. and permit of the introduction of an internal longitudinal track to serve all the stall tracks, and facilitate the handling (by push trucks) of seats, backs, sash trimmings, etc., between the different sub-departments. The stalls reserved for truck work should be equipped with overhead cranes or hoists, as modern heavy trucks cannot be economically handled without them.

In the case of the paint shop, both dimensions may be curtailed, and a track spread of 18 ft., center to center, appears to be sufficient and has been adopted in the large and modern paint shops at Collinwood, Burnside and Concord. A recent examination of a large new shop with tracks spread 20 ft., center to center, shows that room between stall tracks is actually wasted. Similarly, the roof span may be reduced from 100 ft. to 90 ft. and still give plenty of room for paint shop work; the 100-ft. shops at Baring Cross and Montreal are luxurious. Although a clear span of roof truss without intermediate supporting posts is greatly to be preferred in a repair shop, yet the roof truss may be cheapened and intermediate posts used to positive advantage in a paint shop, where they serve a useful purpose in supporting the adjustable trestles with which every modern paint shop should be equipped.

A height of about 20 ft. from floor to lower chord of roof truss is ample for buildings in which passenger equipment cars are to be handled; this height permits of the use of cranes or hoists in those bays of the repair shop where trucks are to be handled and turned.

In twenty years the width of transfer table pits (for handling passenger equipment cars) has increased from 60 ft. to 80 ft., the latter width being found at Elizabethport, Omaha and Burnside. At Elizabethport the pit is 800 ft. long and covers 64,000 sq. ft. or nearly one and one-half acres. With such large pits it pays to equip the tables with large and powerful motors, and some recent installations are speeded to run at 400 ft. per minute light, and 200 loaded. As passenger equipment cars cannot be conveniently handled by cranes, the transfer table becomes a necessity, although it takes up a great deal of yard room and stands idle much of

TABLE 11.—ESSENTIAL DIMENSIONS OF TRANSVERSE PASSENGER REPAIR SHOPS, PAINT SHOPS, AND TRANSFER TABLES.
(In some cases the figures are approximate only.)

Place.	Railroad.	Repair Shop: Spread of Stall Tracks C. to C. (Feet.)	Repair Shop: Span of Bldg. (Feet).	Transfer Table: From Shop to Pit (Feet).	Transfer Table: Width of Pit (Feet).	Transfer Table: From Shop to Pit (Feet).	Paint Shop: Spread of Stall Tracks C. to C. (Feet).	Paint Shop: Span of Bldg. (Feet).
Burlington, Iowa	C., B. & Q.	22	90	50	60	50	22	90
Chicago, Ill.	C. & N. W.	20	80	20	60	20	20	80
Elizabethport, N. J.	C. R. R. of N. J.	20	100	50	80	30	20	150
Collinwood, Ohio	L. S. & M. S.	20	100	23	75	16	18	160
Baring Cross, Ark.	M. P.	22	100	70	70	70	22	100
Montreal, Can.	C. P.	24	100	30	75	100	24	100
Omaha, Neb.	U. P.	22	175	85	80	35	23	175
Knoxville, Tenn.	Southern.	20	90	100	60	100	20	90
Burnside, Ill.	I. C.	20	160	80	80	25	18	160
Concord, N. H.	B. & M.	19	170	82	70	82	18	165
Bloomington, Ill.	C. & A.	21	90	17	70	38	21	90
Topeka, Kan.	A., T. & S. F.	20	90	65	65	15	20	90
Morris Park, N. Y.	L. I.	18	85	15	75	15	18	85
Readville, Mass.	N. Y., N. H. & H.	24	225	25	75	100	24	225
San Bernardino, Cal.	A., T. & S. F.	22	110	100	70	80	22	90
Altoona, Pa.	P. R. R.	Longitudinal shop.			60	80	20	134

the time. It is often, also, an obstruction to the free movement of men and materials between adjacent buildings, and it is believed that this objection will be met in some future installations by locating the pit on one edge of the property, with buildings on one side of it only. The distances between pit and adjacent buildings (as shown by Table 11) vary from a maximum of 100 ft. on both sides at Knoxville to a minimum of 15 ft. on both sides at Morris Park. The old idea was that in case of fire cars would be shoved out into the space between shop and pit; but experience showed that this was seldom or never done. Meantime, the development of fire protection, with brick buildings, concrete floors, fire pumps, electric fire alarm systems, watchmen's clocks, division walls with automatic sliding doors, etc., has minimized the fire risk. At the same time people are realizing that steps saved means money saved, and the present tendency is to bring as close together as circumstances permit all such buildings as constantly exchange business with one another; witness Collinwood, with distances of 23 ft. and 16 ft. on either side of pit. If the layout conditions permitted, an ideal arrangement would be to reserve, say, 40 ft. on repair shop side (sufficient for doors and a pair of six-wheel trucks) and, say, 15 ft. on paint shop side (sufficient for doors and a hand truck); with an 80-ft. pit this would mean 135 ft. between buildings, which, though a minimum, would yet be a considerable distance for men and materials to overcome. In extreme cases, where land was scarce or costly, the distances between pit and buildings could be further reduced, and, to compensate for the loss of external track storage space, additional intermediate stub tracks could be introduced; this has been done in several instances. In northern latitudes heavy snowfalls in transfer pits must be reckoned with. Three courses of treatment are open: The transfer table in a shallow pit may be equipped with snowplows or scoops and be kept running and manned during each fall of snow; the pit may be made very deep and the table shallow, in which case there will be storage space for a large volume of snow; and lastly, the entire pit may be covered with a shed roof. Modern practice favors the use of shallow tables with several rail supports, rather than deep girders with only two rail supports, which latter arrangement forbids the use of the frequent high-level cross footwalks with which every transfer table pit ought to be equipped.

A wooden floor is most desirable for the repair shop, while a concrete floor, surfaced with cement, suits paint shop conditions best; this permits of forming gutters just outside of the track rails, by which car washings may be led off to the sewer. The fan system of hot-air heating is best adapted for these two departments. In the paint shop a liberal supply of warm, dry air judiciously directed will curtail the period of drying and increase the output of the shop. The amount of air supplied to the paint shop must be very much greater than that supplied to the repair shop. The temperature of the paint shop air supply may also be considerably higher, both on account of the drying problems and because the workmen are less actively employed in the paint shop than in the repair shop. These facts should be borne in mind in proportioning the heating apparatus.

As buildings for passenger car repairs and painting are necessarily broad, low structures, the conditions for day lighting from above are favorable, and the saw-tooth form of roof construction is applicable and has been used in some recent installations. When, however, ordinary skylights are used they should be located, to produce the best effects, between tracks rather than over tracks, although the latter arrangement is the more obvious one architecturally.

The upholstery shop, trimming shop, varnish room and storage space are accessories of the repair and paint shop departments concerning which there is no uniformity of practice, either as regards the amount of floor space reserved per car or their relative arrangement and grouping. On listing some twenty shops it is found that in some few cases these accessories are all adjuncts of the repair shop, in a few others are all incorporated with the paint shop, but in most cases are divided between the two, but not in accordance with any uniformity of practice. When considered collectively it is found that the floor space per car (including both cars in repair shop and cars in paint shop) averages about 263 sq. ft., which may be taken as indicating that 250 sq. ft. will answer and 275 sq. ft. will be liberal. It should be understood that the cabinet shop and the paint storehouse do not come under the head of accessories. The convenient grouping of these subdepartments and their relation to the repair shop and the paint shop has a considerable influence on the output of the shop. The point to be borne in mind is that although strippings and trimmings may be removed from cars in either the repair shop or the paint shop, they are almost always replaced in the paint shop.

TABLE 12.—OUTPUT OF PASSENGER CAR REPAIR SHOPS.

(Repair shops and paint shops considered collectively.)

Place.	Railroad.	Average Total No. of Cars. Under Repairs.	Output per Month.	
			Total.	Per Stall.
Boston, Mass.	B. & A.	40	35	0.88
Morris Park, N. Y.	L. I.	38	43	1.13
McKee's Rocks, Pa.	P. & L. E.	5	7	1.40
Milwaukee, Wis.	C., M. & St. P.	24	20	0.83
Aurora, Ill.	C., B. & Q.	40	28	0.70
Roanoke, Va.	N. & W.	20	16	0.80
Sedalia, Mo.	M., K. & T.	12	20	1.66
Decatur, Ill.	Wabash.	12	13	1.08
Reading, Pa.	P. & R.	77	65	0.84
Elizabethport, N. J.	C. R. R. of N. J.	40	60	1.50
Detroit, Mich.	M. C.	22	20	0.91
Bloomington, Ill.	C. & A.	20	29	1.45
Green Island, N. Y.	D. & H.	16	26	1.62
Chicago, Ill.	C., R. I. & P.	17	27	1.59
Montreal, Can.	G. T.	17	25	1.47
Portsmouth, Va.	S. A. L.	13	16	1.23
Brightwood, Ind.	C., C., C. & St. L.	18	13	0.72
Concord, N. H.	B. & M.	28	38	1.36
Albany, N. Y.	N. Y. C.	120	155	1.29
Olwein, Iowa	C. G. W.	12	9	0.75
Topeka, Kan.	A., T. & S. F.	30	42	1.40
Middletown, N. Y.	N. Y., O. & W.	10	16	1.60
Baltimore, Md.	B. & O.	46	69	1.50
Burnside, Ill.	I. C.	55	61	1.11
Collinwood, Ohio.	L. S. & M. S.	41	75	1.34
Springfield, Mo.	St. L. & S. F.	20	15	0.75

Table 12 gives the output of a number of passenger car repair plants. The work of repairs and repainting is often carried on simultaneously, so that, in treating of output questions it becomes preferable to consider the two subdivisions collectively. It is not proposed to examine in detail into the causes which result in such wide variations of output; they are many and complex and can be discovered only by investigation on the ground, but it is a fact that two of the plants which show the lowest output have longitudinal shops, while all of those which show both a large total and a large unit output have transverse shops; it is also known that these latter have the best proportioned and arranged accessories and the most modern and effective heating arrangements. When attention is focussed on the problem of securing maximum output from a given plant it is at once found that cars should be fed into the shop as fast as finished cars are taken out, and that no stall should be allowed to stand unoccupied. Examining the table, it is evident, however, that a well designed and appointed plant, where work is done on a large scale, ought to yield an output of at least 1.50 cars per stall per month, meaning by a stall a piece of track which is actually used for standing cars under repairs; space for truck repairs and caboose work, if done in repair shop, and for tank work, if done in paint shop, should be extra. The cabinet shop will be treated under a separate head, and it is unnecessary to say that its equipment and arrangement, and its location relatively to the repair shop, have a large share of influence in affecting output.

The relative number of cars to be under repair shop treatment and paint shop treatment at the same time is somewhat uncertain, but it is believed that, in general, the paint shop should stand twice as many cars as the repair shop, or, to put it in another way, that one-third of the cars should stand in the repair shop and two-thirds in the paint shop.

(To be continued.)

NEW PASSENGER LOCOMOTIVES.

PACIFIC OR 4—6—2 TYPE.

CHICAGO, ROCK ISLAND AND PACIFIC RAILWAY.

At the Brooks works of the American Locomotive Company new locomotives of the 4—6—2 type have been built for the Chicago, Rock Island & Pacific Railway and are now in service. Mr. M. K. Barnum, superintendent of motive power, states that they are intended to haul trains of eight and ten cars on a 1 per cent. grade and maintain speeds of from 30 to 35 miles per hour. They are reported to be satisfactory in steaming qualities and in handling heavy trains at high speeds. The photograph shows at a glance the designer's successful efforts to produce an attractive appearance.

This design employs piston valves with internal admission and very short valve stems. The connections to the stems are made by links, the rockers being placed in front of the guide yokes. It also includes the Player radial trailing truck, which is giving excellent results under many wide firebox locomotives. In connection with the table of dimensions it will be noted that the main driving journals are 9½ by 12 ins.

At the front water leg of the boiler a water space of 4 ins. is provided at the mud ring, and this enlarges rapidly above, to secure space for delivery of water to the sides of the firebox. The tubes are 2 ins. in diameter and spaced at a pitch of 2 15-16 ins. There is a single "hen and chickens" fire door 28 ins. wide.

This engine has air brakes on the trailing wheels as well as the drivers. A comparison of a number of designs of this type of passenger locomotives is presented in the following table:

COMPARISON OF PACIFIC TYPE LOCOMOTIVES.

Road.	Total Weight.	Heating Surface.	Tractive Effort.
Chicago & Alton	219,000	4,078	31,600
Chicago & Alton	217,300	4,078	36,600
Northern Pacific	202,000	3,462	31,000
Chesapeake & Ohio	187,000	3,533	31,900
Missouri Pacific	173,000	2,953	25,700
Chicago, Rock Island & Pacific	192,800	3,104	28,300

RATIOS OF CHICAGO, ROCK ISLAND & PACIFIC LOCOMOTIVES.

Heating surface to cylinder volume	= 298.5
Tractive weight to heating surface	= 41.88
Tractive weight to tractive effort	= 4.59
Tractive effort to heating surface	= 9.11
Tractive effort × diameter of drivers to heating surface	= 629.
Heating surface to tractive effort	= 10.9%
Total weight to heating surface	= 62.11

Since this table was prepared the actual weights of the locomotive have been taken, which are as follows: On driving wheels, 132,300 lbs.; on leading truck, 32,300 lbs.; on trailing wheels, 28,400; total, 193,000 lbs. The chief dimensions are as follows:

PACIFIC TYPE PASSENGER LOCOMOTIVE.

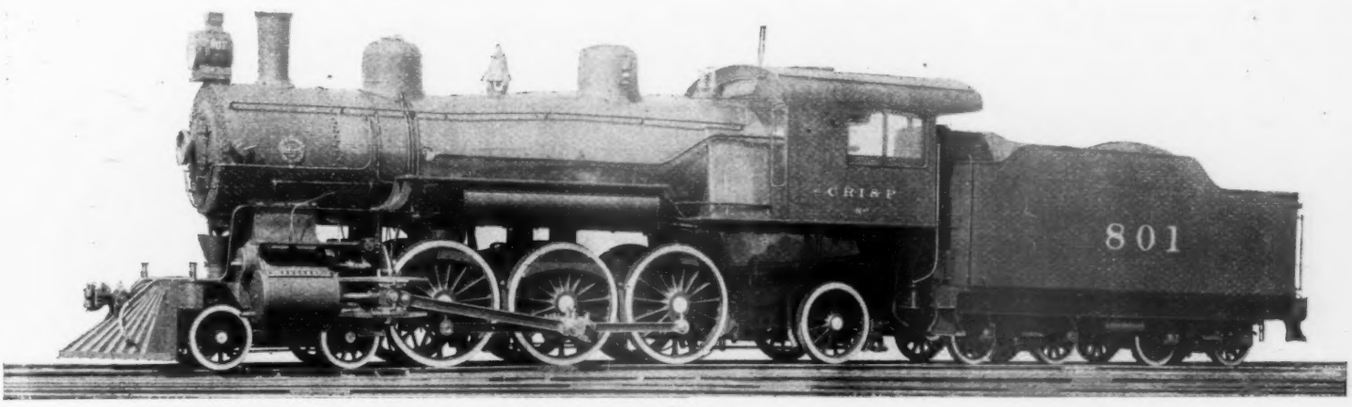
BUILT FOR CHICAGO, ROCK ISLAND & PACIFIC RAILWAY COMPANY.

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	192,800 lbs.
Weight on drivers	130,000 lbs.
Weight engine and tender in working order	145,000 lbs.
Wheel base, driving	12 ft. 4 ins.
Wheel base, rigid	12 ft. 4 ins.
Wheel base, total	31 ft. 10 ins.
Wheel base, total, engine and tender	58 ft. 9 ins.

Cylinders.

Diameter of cylinders	21 ins.
Stroke of piston	26 ins.
Horizontal thickness of piston	7 ins.
Diameter of piston rod	3¾ ins.
Size of steam ports	65 ins.
Size of exhaust ports	1⅞ ins. x 25½ ins.
Size of bridges	3 ins.



PACIFIC—4—6—2 TYPE PASSENGER LOCOMOTIVE—CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.
M. K. BARNUM, SUPERINTENDENT MOTIVE POWER AMERICAN LOCOMOTIVE COMPANY, BROOKS WORKS, BUILDERS.

Valves.

Kind of valves	Piston
Greatest travel of valves	5½ ins.
Outside lap of valves	1⅛ ins.
Inside lap of valves	0 ins.
Lead of valves in full gear	1-32 in.

Wheels, Etc.

Number of driving wheels	6
Diameter of driving wheels outside of tire	69 ins.
Material of driving wheel, centers	Cast steel
Thickness of tire	3½ ins.
Driving box material	Cast steel
Diameter and length of driving journals	9 x 9½ ins.
Diameter and length of main crank pin journals	6½ ins. diameter x 6½ ins.
Diameter and length of side rod crank pin journals	7⅝ ins. diameter x 4¾ ins.
Engine truck journals	6 ins. diameter x 12 ins.
Diameter of engine truck wheels	33 ins.

Boiler.

Style	Radial stayed extended wagon top
Outside diameter of first ring	66⅛ ins.
Working pressure	200 lbs.
Thickness of plates in barrel and outside of firebox	11-16, 23-32, ¾, 9-16, ½, ½ in.
Firebox, length	84 ins.
Firebox, width	74 ins.
Firebox, depth	Front, 76½ ins.; back, 65 ins.
Firebox plates, thickness	Sides, ⅝ in.; back, ¾ in.; crown, ⅜ in.; tube sheet, ⅝ in.
Firebox, water space	4 ins. front, 3½ ins. sides, 3½ ins. back
Firebox, crown staying	1 in.
Firebox, stay bolts	1 in.
Tubes, number	300
Tubes, diameter	2 ins.
Tubes, length over tube sheets	18 ft. 7 ins.
Heating surface, tubes	2,940 sq. ft.
Heating surface, firebox	164 sq. ft.
Heating surface, total	3,104 sq. ft.
Grate surface	422 sq. ft.
Exhaust nozzles	5¼ ins. diameter
Smoke stack, inside diameter	15 and 17⅛ ins.
Smoke stack, top above rail	15 ft. 7 ins.
Boiler supplied by	Two 11 Nathan simplex

Tender.

Style	Eight-wheeled
Wheels, number	8
Wheels, diameter	36 ins.
Journals, diameter and length	5½ ins. diameter x 10 ins.
Wheel base	18 ft.
Tender frame	13-in. channels
Tender trucks	Barber
Water capacity	7,000 U. S. gals.
Coal capacity	15 tons

STEEL CAR DEVELOPMENT.

PENNSYLVANIA RAILROAD.

I.

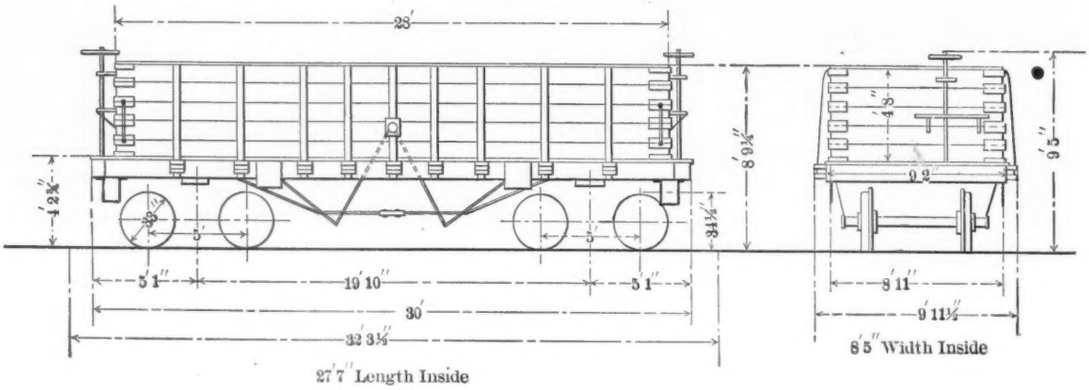
In January, 1896, the first steel cars for general service on the Pennsylvania Railroad were built by the Keystone Bridge Works, the beginning being contemporaneous with that of the Pittsburgh, Bessemer & Lake Erie Railroad, which was recorded in this journal in May, 1903, page 168. In fact, the officers of the Pennsylvania Railroad were intimately associated with those of the Carnegie Steel Company in the early stages of this development with respect to matters of design. Credit for the introduction of steel cars in this country therefore belongs equally to these two companies. The Pennsylvania system now has 46,696 steel cars in service, including those with steel underframes.

The Pennsylvania had built steel cars for special service dating back to 1887, when the FD class were constructed. These weighed 51,800 lbs. and were designed to carry a concentrated load of 120,000 lbs. and were built for special service in transporting heavy wire rope cables for cable railroads.

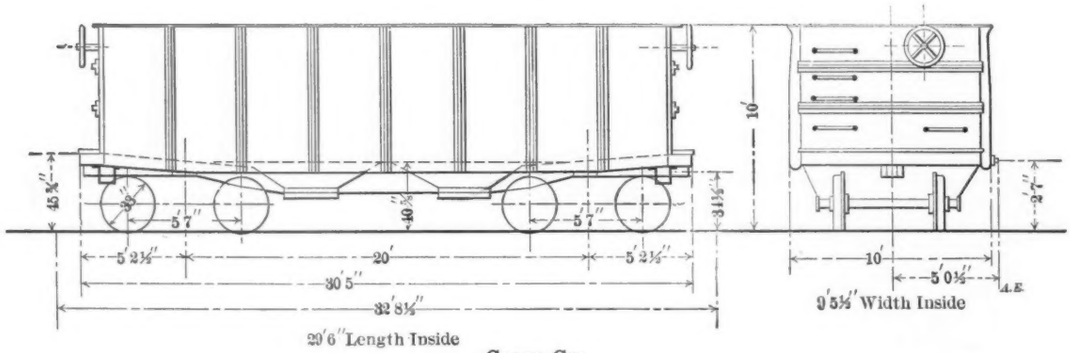
The class designations of the freight equipment of this road are as follows: Box cars, X; refrigerators, R; charcoal cars, L; stock, K; gondolas, G; flats, F; cabin, N; dump, U; wrecking or derrick, W. Suffix letters indicate succession in design, and second suffix letters indicate minor modifications of design, with reference to such details as height of sides and character of end doors, as in the case of gondola cars. In all cases the first letter designates the class.

In March, 1895, the GG car was built from drawings prepared at Fort Wayne after a study of all existing types of heavy coal cars. It was a wooden hopper car and is believed to be the first large self-clearing hopper car ever built. This design has exerted a controlling influence over subsequent practice in steel cars. The first car weighed 35,200 lbs. and carried 70,000 lbs. of coal, the ratio of dead to paying load being 45.7 per cent. The original drawing of this car bears the date March 15, 1895, and the names of G. L. Potter, then superintendent of motive power of the Northwest System, and William Stephan, chief draftsman. The construction will be illustrated, because its general features were adopted in steel by the Schoen people, both on the Pennsylvania and the Pittsburgh, Bessemer & Lake Erie, and afterwards for general introduction.

In 1896 the Carnegie Steel Company were experimenting with steel cars, and at the same time the GM steel car was designed by the Pennsylvania at Altoona. Five of these cars were built by Mr. Charles T. Schoen. They were gondolas with two small hoppers, but the car was not self-discharging. It had double drop-bottom doors. It was designed for use on the Pennsylvania Lines. Its cubical capacity was 2,038 cu. ft., including a heap averaging 9 ins. high above the tops of the sides. Its weight was 33,500 lbs. and capacity 100,000 lbs., giving a ratio of dead weight to paying load of 30.73 per cent. No other steel cars of this capacity have been built which weighed so little. This was the first steel car on the Pennsylvania and the five are now giving satisfactory service from the standpoint of maintenance, but the design has never been



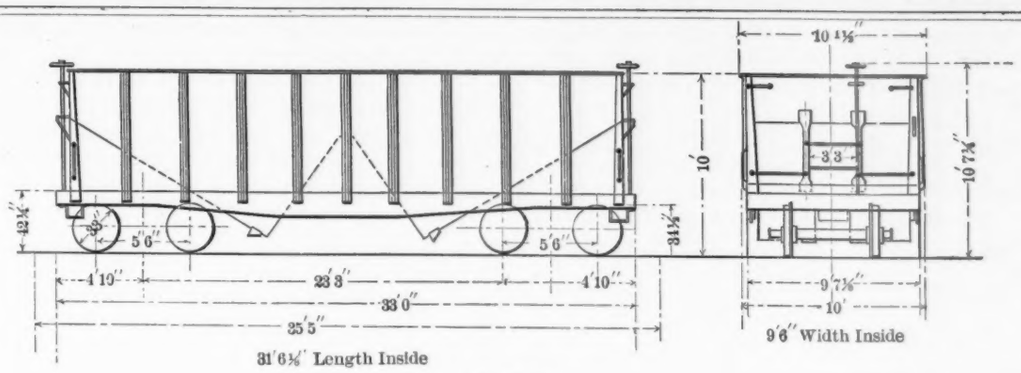
CLASS GG.



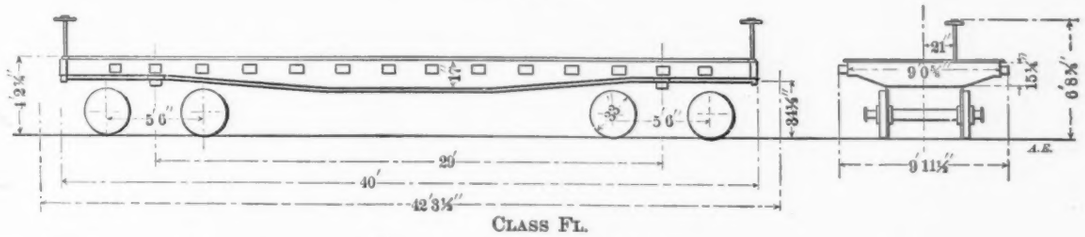
CLASS GM.

popular because of the necessity for shoveling the load through the drop doors. This car had no side sills, the sides being employed as trusses to assist in carrying the load. Thus this important principle, which seems to be considered a recent discovery, was embodied in the very first step taken by this road in its introduction of steel cars into general road service. These cars were carried on Vogt steel trucks and were fitted with single-spring double gear. The first GM cars were delivered by the Pressed Steel Car Company, June 1, 1898.

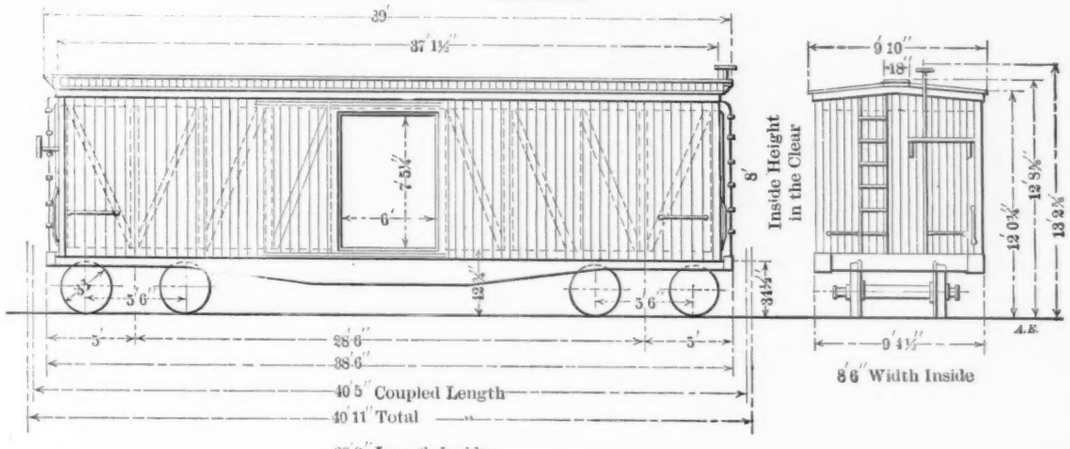
The GL design was the result of conferences between the mechanical officers of the Pennsylvania Railroad, the Pennsylvania Lines West and the Schoen people. The drawings were contemporaneous with those of the GM design, though the construction was later. The GL car is a self-clearing hopper of 100,000 lbs. capacity and is now the standard of that type of equipment on the Pennsylvania system. This car is self-dumping and was very popular from the first. Its adoption as a standard gave steel car building a powerful



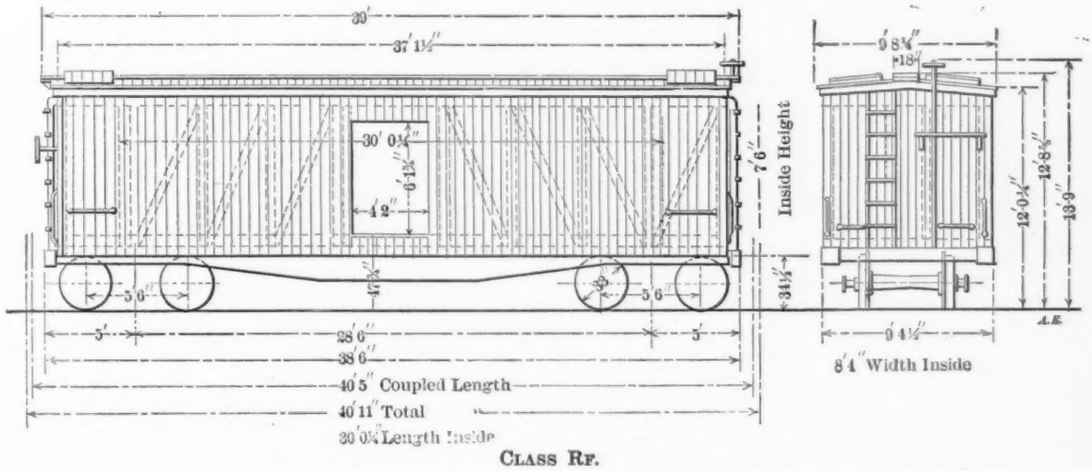
CLASS GL.



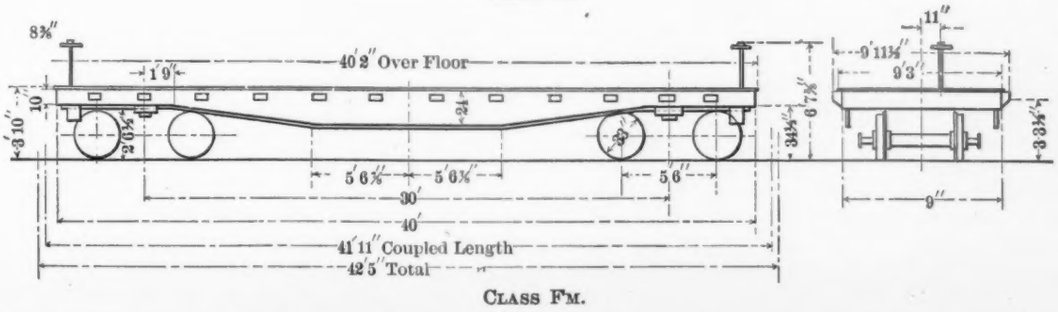
CLASS FL.



CLASS XL.



CLASS RF.



CLASS FM.

STEEL CAR DEVELOPMENT—PENNSYLVANIA RAILROAD.

impetus and it is interesting to note that this type has always led in popularity and that all self-clearing cars which have been built in large numbers have followed this general arrangement.

Details for the GL car were developed by the Schoen Pressed Steel Company and pressed steel was used in their construction. The first cars of this class were used on the lines west of Pittsburgh, carrying coal to the lake ports and returning to Pittsburgh with ore. For this reason it was a very profitable class of equipment and was from the first severely tested in service which was both important and conspicuous. Solid trains of these cars attracted attention to their advantages and this led to a very rapid development of facilities for building them, and these have been taxed to meet the demands for this equipment. The first GL cars went into service July 27, 1898.

This class is now practically the same as the original designs, but it is to be re-designed and lightened, without impairing its strength. For example, the side sills are pressed steel channels extending the full length of the car. These are not needed because of the very deep plate girders formed by the sides. Its dead weight is 36.36 per cent. of the paying load, as compared with 45.7 per cent. in the GG wooden hopper car.

An interval of about four years was allowed for a thorough service test of the GL cars both east and west of Pittsburgh before other designs were put into the form of construction. A number of experimental trucks were used and a careful watch was kept as to the performance of details. In the light of this experience several new car designs were prepared. An examination of the drawings indicates that these were based more or less closely upon a general scheme, which may be said to embody: (1) A backbone of two sills with cover plates, reaching nearly the full distance between the end sills. (2) Diaphragms in the bolsters with cover plates at top and bottom. (3) Bolsters 10 ins. deep at the center, with one top and one bottom cover plate. The bottom plate is wide at the center, to act as a gusset. (4) Two very heavy cross-bearers 24 ins. deep, to compel the sills to act together. These are used only on gondolas and flat cars, which are designed to carry concentrated loads. They are also used on GS cars which do not have side sills. In this case they are used for the purpose of transferring the load from the sides to the backbone on center sills. Other cars which, like box cars, do not carry concentrated loads, do not include these cross-bearers. (5) Diagonals from the ends of the bolsters to the ends of the center sills.

The later cars include flat, gondola, box and coke cars. The coke car is a design for special service and will be described later. The small diagrams indicate the character of this equipment. Another principle in this construction is the provision for "concentrated loads." It is assumed that two-thirds of the capacity of certain cars may be carried on a line at the center of the car or anywhere between the cross-bearers. The GR and FM classes provide for concentrated loads. GS is for a uniformly distributed load. It has a flat floor and solid ends. GSA has a flat hopper bottom and solid ends. GSB has no hopper and has drop ends. GSC has both hopper bottom and drop ends.

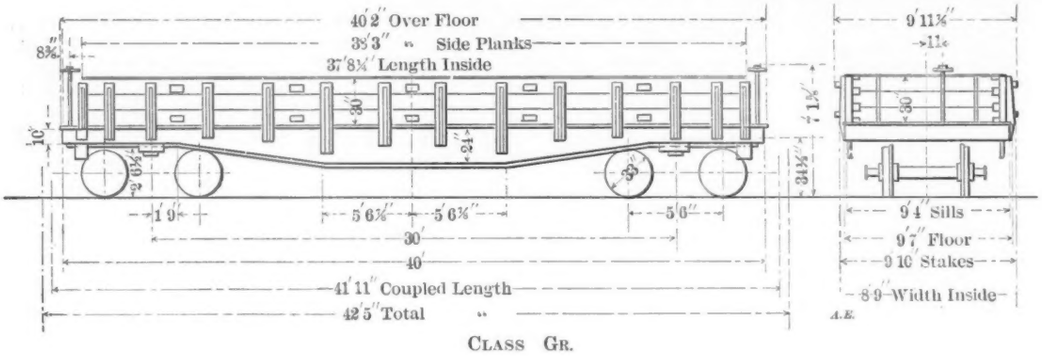
In the matter of sill construction the greatest depth of center and side sills for 33-ft. GL cars is 17 ins. For box cars 38 ft. 6 ins. long over end sills the depth is 17 ins. For concentrated loads and cars 40 ft. long or over the depth is 24 ins.; for uniform loads and cars of the GS types 40 ft. long the greatest depth of the center sill is 20 ins. There are no side sills in this design. This can hardly be said to constitute a rule of construction, but these depths have been established as satisfactory. More will be said later as to the sections of the sills and the necessity for reinforcing pressed steel channels for some of these classes.

STEEL CARS—PENNSYLVANIA RAILROAD.

TABLE OF CAPACITIES.

Class.	Capacity Box.	Heap.	Total.	Pounds.	Weight.
GG	933 cu. ft.	175 cu. ft.	1,108 cu. ft.	70,000	35,200 lbs.
GM	1,861 cu. ft.	203 cu. ft.	2,064 cu. ft.	100,000	33,800 lbs.
GL	1,672 cu. ft.	225 cu. ft.	1,897 cu. ft.	100,000	39,150 lbs.
EL	Flat car			80,000	31,500 lbs.
XL	Box car			100,000	45,300 lbs.
RF	Refrigerator car			90,000	.....
FM	Flat car			100,000	40,000 lbs.
GR	824 cu. ft.	247 cu. ft.	1,071 cu. ft.	100,000	44,000 lbs.
GS	1,331 cu. ft.	266 cu. ft.	1,597 cu. ft.	100,000	38,400 lbs.
GSA	1,379 cu. ft.	266 cu. ft.	1,645 cu. ft.	100,000	40,200 lbs.
GSB	1,312 cu. ft.	262 cu. ft.	1,575 cu. ft.	100,000	.....
GSC	1,361 cu. ft.	262 cu. ft.	1,623 cu. ft.	100,000	39,800 lbs.

Next in order came the FL, an 80,000 lbs. capacity flat car. It was experimental and served to supply a great deal of information with reference to deflection and twisting of sills under loads. Class XL is the box car which was designed



CLASS GR.

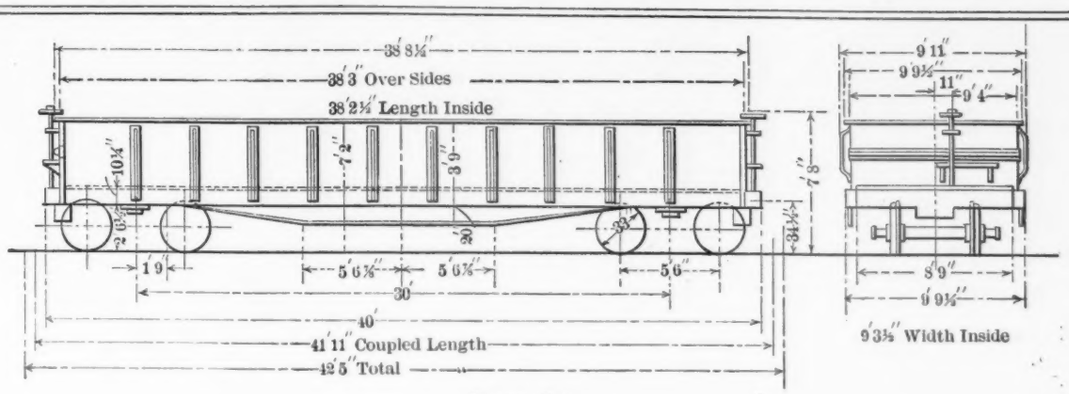
immediately after the American Railway Association had decided upon the dimensions—36 ft. long, 8 ft. 6 ins. wide and 8 ft. high as standard for 40-ton box cars. A capacity of 100,000 lbs. was decided upon because, the inside dimensions being given, the weight and cost of a 50-ton car would be little more than that of a 40-ton. It was found that 110,000 lbs. of grain could be loaded into this car, and this led to the decision as to capacity. No other class of box cars is now being built by the Pennsylvania. In all probability the cost of hauling a ton a mile is so low that with an occasional full load for a long trip, the cost of hauling the additional weight of a 50-ton over a 40-ton car could be earned several times every year. With pneumatic loaders cars may be loaded to the car lines with grain without hand trimming.

Class XL has a low floor to meet the standard dimensions. In this design cover plates and flange angles first appeared, the purpose being to gain strength. The greatest depth of the sills is 17 ins. and the neutral axis was raised by the cover plates. These cars are designed for distributed loads.

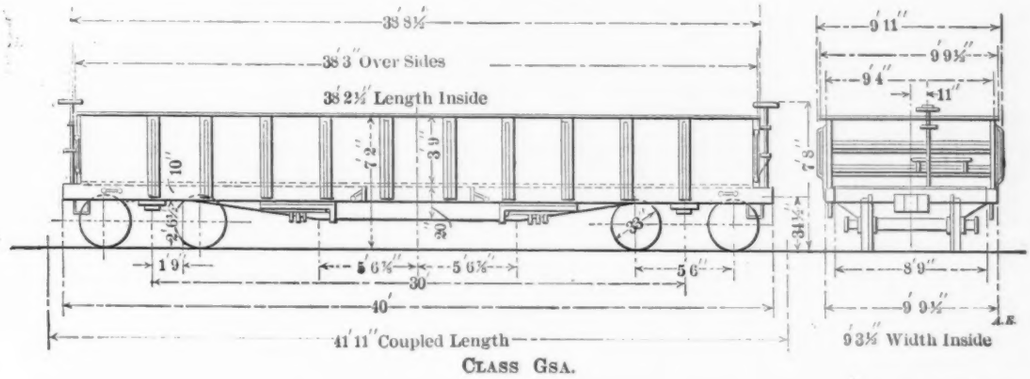
Class RF is a 90,000-lb. refrigerator, built to standard dimensions and with the underframe of class XL. These inside dimensions provided width enough to get in one more tier of boxes in box shipments than the previous standard and also gave room for larger ice boxes.

Class FM is a 100,000-lb. flat car, succeeding class FL. FM has 24-in. sills, which are the deepest pressed sills made, whereas those of FL were but 17 ins. deep. Class FM provides for concentrated loads and is strong enough to carry two-thirds of its capacity on the middle third of its length.

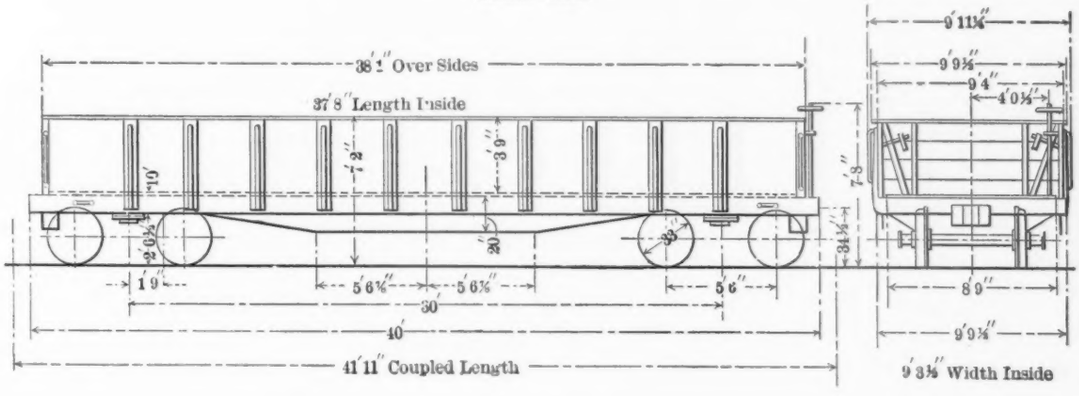
Class GR has practically the same frame as FM but could be made wider on account of the absence of stake pockets. This car was built for concentrated loads inside or on top of



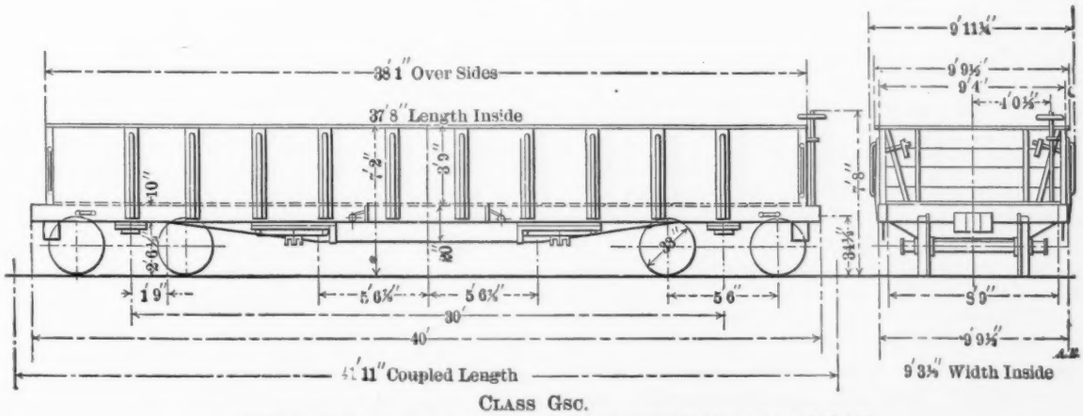
CLASS Gs.



CLASS GSA.



CLASS GSB.



CLASS GSC.

STEEL CAR DEVELOPMENT— PENNSYLVANIA RAILROAD.

its sides. It has 24-in. center and side sills and wooden sides, not being intended for coal.

There are four subdivisions of the Gs class, all being designed for coal service on the lines west of Pittsburgh. The officers of this road believe that coal cars should have floors as nearly tight as possible in order to protect the substructure from corrosion, which would impair its integrity and strength. If a car stands with a load of coal containing sulphur, water will leach out the sulphur and form a weak solution of sulphuric acid, which is worse than a concentrated solution in its effects upon iron and steel. This weak solution does the work of a cape chisel and hammer. The box structure of a car may be easily patched and repaired, but this is not true of sills, bolsters and truck members. The Gs cars are the same length as GB and have 20-in. center sills with no side sills. They all have solid floors.

Details of the most important of these designs will be presented, together with some further discussion of the principles involved in their construction. We are indebted to the officers of the motive power department of the Pennsylvania Railroad for courtesies in connection with this description.

NEW LOCOMOTIVE SHOPS.

READING, PA.

PHILADELPHIA & READING RAILWAY.

VII.

(*For Previous Article, See Page* 235.)

THE ELECTRIC POWER AND LIGHTING DISTRIBUTION SYSTEM.

The considerations which led to the adoption of the two-phase alternating current system of electric power distribution for the new Reading locomotive shops are interesting and very important. This question was given a very thorough investigation by the officials of the road and it is interesting to note the bearing that local conditions had upon the ultimate solution of the problem.

In the first place the plans for the shops included 14 electric cranes, varying in capacity from 5 to 120 tons, all of which would require variable speed motors, and some would have as many as six motions. The only type of motor naturally adapted to this class of service is the series, direct-current motor, having the regular street railway motor characteristics; the alternating current induction motor, even if arranged for variable speeds, was not considered satisfactory for work of this nature, which requires starting from rest under full load and accelerating rapidly. These considerations made it seem necessary that the power plant should supply direct current.

It was also planned to supply from the power plant, power and light to other departments of the road located in Reading, including current for 300 h.p. of motors at the car repair plant, 2,400 ft. distant, current for 145 arc lamps for illuminating the railroad yards and other departments in the city, together with several power transmissions from 1,000 to 3,000 ft. in length. For such service as this alternating current is much more desirable than direct current, as is well known. A careful study of these conditions resulted in a compromise in the matter, and it was decided to supply both alternating and direct current from the power plant in order to care for both classes of service.

ARC LIGHTING.

In this connection the question as to the type of arc lamp to use became a very important subject, as there are three prevailing systems of operating arc lights: First, the direct-current series system (requiring special series dynamos); second, the direct or alternating current multiple system; and third, the alternating-current series system (using series constant-current transformers). It was considered very undesirable to make use of the first-mentioned system on account of the complication that would be introduced into the power plant equipment by use of the comparatively small series dynamos. Consequently the question narrowed itself down to the exclusive use of the alternating-current series system throughout for both exterior and interior, or a combination of the multiple system for interior lighting and the series-alternating system for outside illumination, covering extended areas, as the multiple system was absolutely prohibitive for the latter work on account of the enormous amount of copper required for the distribution. Finally, however, the desirability of having a standard type of arc lamp, for both inside and outside use, thus reducing the number of spare parts to a minimum, together with consideration that the inside lamps were all to be located at sufficient distances above the floor to place them out of the way of harm and that the wiring was to be located in protected positions permitting high voltages, led to the adoption of the series, inclosed, 6.6-ampere, alternating-current lamp for both outside and inside use.

TYPE OF GENERATORS.

These decisions resulted in requiring that both alternating and direct current should be furnished from the power plant, after which the remaining question to be decided was the form of current that should be generated there as a primary basis of power supply. In determining this point, calculations were made of all the power that should be required for the various purposes for which it was to be supplied. The amount of power that would have to be supplied in the form of direct current for the crane motors and also for the variable-speed motors to be used for the individual drives on certain of the machine tools, and for all other purposes, was carefully determined; then the amount of power that would be delivered in the form of alternating current for the induction motors, to be used for all machinery requiring constant-speed driving, for the incandescent lighting and general shop distribution, for the long-distance transmissions, and also that to be used for the arc lighting, was also determined. The results of these calculations showed that only 150 kw. would be required for the direct-current distribution, while 1,050 kw. would have to be delivered in the form of alternating current, the latter being thus far the greater demand to be met. The relative merits of generating the current by the direct or alternating current systems were then considered, with reference to the adoption of the one most suitable for the governing conditions; the results, stated comparatively, are as follows:

ADVANTAGES OF THE DIRECT-CURRENT GENERATING SYSTEM.

(a) Satisfactory motors, both constant and variable speed, may be operated from the same mains.

(b) The power factor is 100 per cent., and this permits motors to start with a minimum of current.

(c) No trouble is experienced in the parallel operation of the generators.

(d) No exciters are required for the generators.

(e) There is no drop of voltage in the mains from inductive losses, as with alternating current.

(f) Slightly lower first cost.

(g) Motors have longer air gap than induction motors.

ADVANTAGES OF THE ALTERNATING-CURRENT GENERATING SYSTEM.

(a) It can readily be transformed from one voltage to another.

(b) Motors do not have commutators and brushes.

(c) The output is not limited by sparking at the brushes.

(d) It can be readily transformed from constant potential to constant current for operating the arc lamps.

(e) It is almost impossible for the armature, or rotating winding, of an induction motor to burn out.

Thus for the plant in question, with several transmissions, constant current (alternating) to be supplied for the arc lamps, and with the alternating current demand so much greater than that for direct current, the use of alternating-current generators offered by far the greater advantages. It greatly simplified the station equipment, as with the multiphase alternating current, rotary converters could be used to transform into direct current the current supply for the crane motors, variable-speed motors, etc.

FREQUENCY AND VOLTAGE TO BE USED.

The number of alternations per second (frequency) at which the alternating current should be delivered from the generators was another important subject requiring attention. On account of the large number of induction motors to be driven, including the rotary converters, it was, of course, thought best to have the frequency as low as possible. But this was limited by the fact that alternating-current arc lamps were not built at that time which would operate satisfactorily at a frequency of less than 60 cycles (7,200 alternations per minute). But, as rotary converters to deliver 250 volts could easily be obtained that would operate satisfactorily, and also as induction motors are entirely satisfactory at this frequency, it was decided to adopt the frequency of 60 cycles per second.

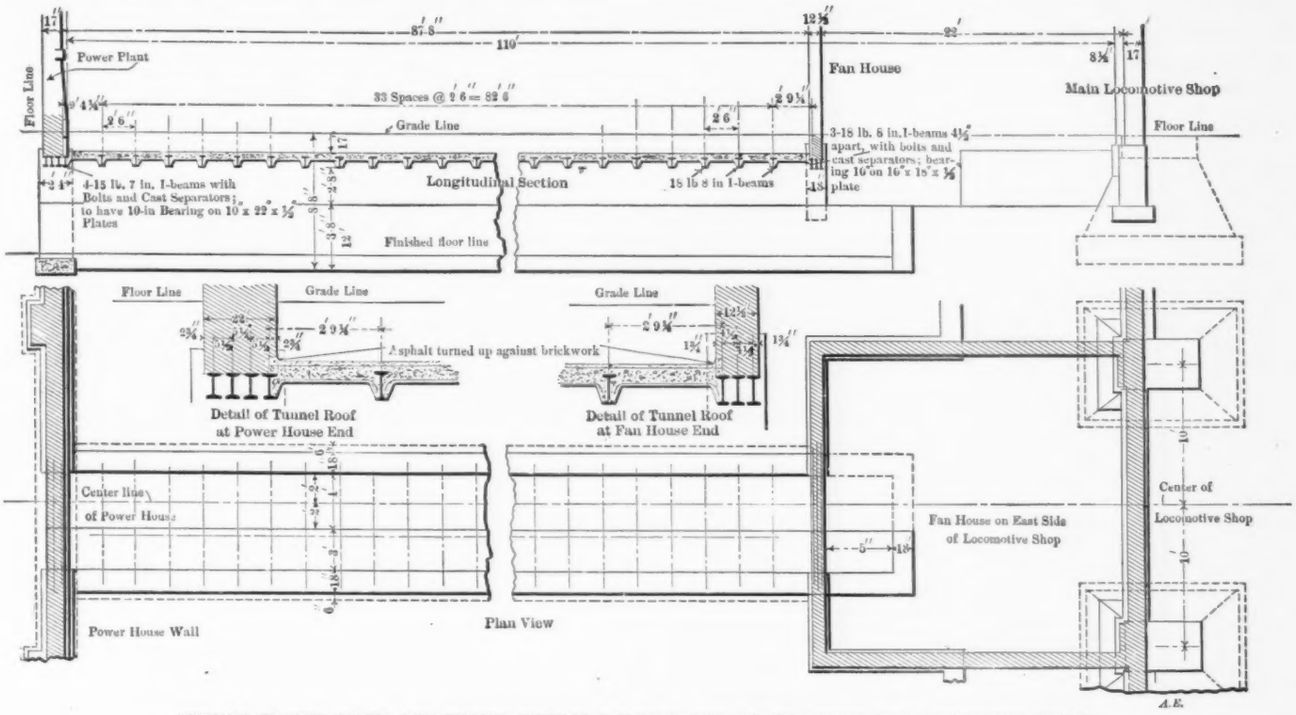
In determining the terminal voltage of the generators, it was decided to operate with as high a potential as could be considered safe, which was especially feasible in the absence of danger from commutator troubles and also as the motors were to be located up on columns out of the way. Four hundred and eighty volts was the figure chosen for the generators, as being satisfactory for the standard induction motors and other alternating-current apparatus built by the two electrical companies supplying this class of machinery. This higher

tion of sulphuric acid, which is worse than a concentrated

for courtesies in connection with this description.

voltage also has the advantage of reducing the cross-section of the feeders to a very small size as compared with what would have been required with the lower voltages.

center of the locomotive shop, and the fact that the greater part of the power delivered was to be used in the locomotive shop, combined to bring the location of the wiring tunnel


Power Plant
Floor Line
87'-8"
110'
33 Spaces @ 2'-6" = 82'-6"
Grade Line
Longitudinal Section
4-15 lb. 7 in. I-beams with Bolts and Cast Separators; to have 10-in Bearing on 10" x 22" x ½" Plates
Finished floor line
15 lb 8 in I-beams
3-18 lb. 6 in. I-beams 4½" apart, with bolts and cast separators; bearing 16" on 16" x 18" x ½" plate
Fan House
Main Locomotive Shop
Floor Line
Asphalt turned up against brickwork
Detail of Tunnel Roof at Power House End
Detail of Tunnel Roof at Fan House End
Center line of Power House
Power House Wall
Plan View
Fan House on East Side of Locomotive Shop
Center of Locomotive Shop
A.E.

DETAILS OF THE PIPING AND WIRING TUNNEL BETWEEN THE POWER HOUSE AND LOCOMOTIVE SHOP. READING SHOPS.—PHILADELPHIA & READING RAILWAY.

NUMBER OF PHASES.

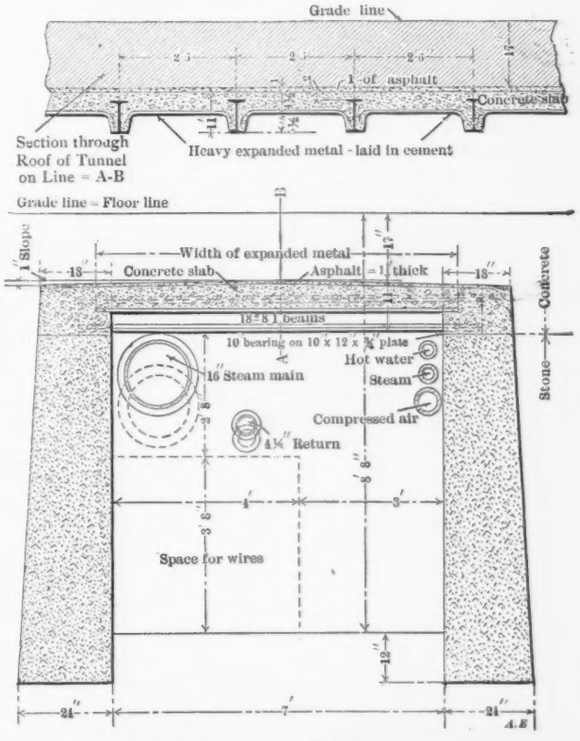
Inasmuch as the operation of large motors on single-phase alternating-current circuits is commercially impracticable, the two and three-phase systems were the only ones considered. In determining between the two, it was considered that, for a plant of this nature, with the great part of the distribution local and no long transmissions, the two-phase system would be more suitable. With the two-phase system there are but two circuits to balance, as compared with three of the three-phase system, and this is very easily done from the switchboard by means of double-throw switches, whereas, with the three-phase system, balancing is complicated. The two-phase system also offers a simple means of starting motors without the use of compensators, auto-starters, etc., as may be noted by reference to the description of the method used, which was published on page 237 of our June, 1903, issue in connection with the description of the power plant.

The two-phase system has the disadvantage of requiring more copper than the three-phase for the distribution system, but it was found that in a local distribution system, as in this case, and particularly with the high voltage used, this item does not become very large and is by no means prohibitive. Also the three-phase system offers distinct advantages over the two-phase system for long-distance transmission; but if a necessity for long-distance transmission should ever arise it was known that it would only be necessary to install a Scott phasing transformer, which would transform the current from two to three phase. In view of these numerous advantages of the two-phase system it was adopted as best suited to the local conditions.

This interesting plan of electrical distribution was worked out by Mr. E. E. Brown, Electrical Engineer, in charge of design and installation, under the direction of Mr. S. F. Prince, Jr., superintendent of motive power, to whom we are greatly indebted for courtesies extended in the preparation of these articles. Further considerations as to the distribution system and motor equipment will appear later.

DETAILS OF THE PIPING AND WIRING TUNNEL.

As stated in an earlier issue (see page 9, January, 1903) the central location given to the power house opposite the



CROSS SECTION OF THE PIPING AND WIRING TUNNEL, SHOWING DETAILS OF ROOF CONSTRUCTION.

very close to the center line of the locomotive shop building. In this way the tunnel also lent itself naturally to accommodate the piping systems that extend from the power house to the locomotive shop, for the steam, compressed air and hot-water supplies. The design of the tunnel, as well as the arrangement of the piping and wiring within it, are of interest.

The details of the tunnel construction are made clear in the two above engravings, one showing a plan and longitudinal section, and the other a cross section. As may be

seen, the shop end of the tunnel has its outlet in one of the heating fan houses. This is of considerable advantage, as a large space is afforded alongside of the heating fan for getting at the pipes and wiring, and for ease of arranging the distribution to the various departments. Also, as the fan rooms are kept locked, the piping valves and the wiring are, with this arrangement, not liable to be interfered with.

An important feature of the tunnel's construction is the roof, which is of concrete, braced by sections of heavy expanded metal which are laid between the 30-inch-spaced supporting I-beams; this is made clear in the cross section drawing. The concrete is covered by a heavy asphalt waterproofing, 1-inch thick, the whole being covered by puddled blue clay. The side walls are of solid concrete. The interesting construction of the roof at the power-house and shop ends of the tunnel is indicated in detail views below longitudinal section on page 357.

The arrangement of the various pipes in the tunnel is indicated in the cross-section view, which also shows the location of the wires. The "space for wires" is filled with the well-known McRoy vitrified clay 4-duct conduits, which are piled to fill the space. These accommodate the feeder cables that run from the switchboard in the power-house, which is located directly over that end of the tunnel to the distribution points. The feeder cables are all lead covered for protection in the tunnels.

As may be noted from the general dimensions of the tunnel interior, it is of sufficient size to permit ease of access, and repairs can be made with a considerable degree of comfort to the workmen—an important feature where good work is desired. The tunnel is well lighted by incandescent lamps, and also is well drained so that it is perfectly dry—an advantage for the electrical wiring.

STEEL FRAME, SIDE-DOOR SUBURBAN PASSENGER CARS.

ILLINOIS CENTRAL RAILROAD.

III.

Previous articles on this subject were printed in this journal June, 1903, page 204, and September, page 327.

The underframe consists of four 9 in. 21 lb. I beams, 64 ft. long and spaced at nearly equal distances apart, giving a total width of 10 ft. 4 ins. over the flanges. The end sills are 9 in. 25 lb. channels set with the backs against the ends of the longitudinal sills and riveted to them with double angle plates and gussets. The underframe is trussed with four truss-rods passing over the inner body bolsters and anchored to the outer ones. Adjustment of these rods is provided by vertical green posts, under the 7 in. 15 lb. needle beams. Over the body bolsters and needle beams 6 in. 12¼ lb. I-beams in short sections are placed between the longitudinal sills as stiffening members and riveted to the webs of the sills by means of angles.

Upon the metal sills a steel floor of ¼ in. plates, 60 ins. in width, is laid with butt joints formed by the planed edges of the plates and extending entirely across the underframe. This floor is riveted to the upper flanges of the sills with double rows of ½ in. rivets. There is thus obtained a continuous metal surface extending the entire length and width of the car, insuring perfect rigidity of the underframe and giving complete protection from fire underneath the car. The underframe is carried upon four body bolsters made of 7 by 1 in. steel bars in the upper and lower members. The bolsters are arranged in pairs, 4½ ft. centers, and bolted to the lower flanges of the sills. Heavy truss connections extend between the bolsters, to which are bolted the center plates.

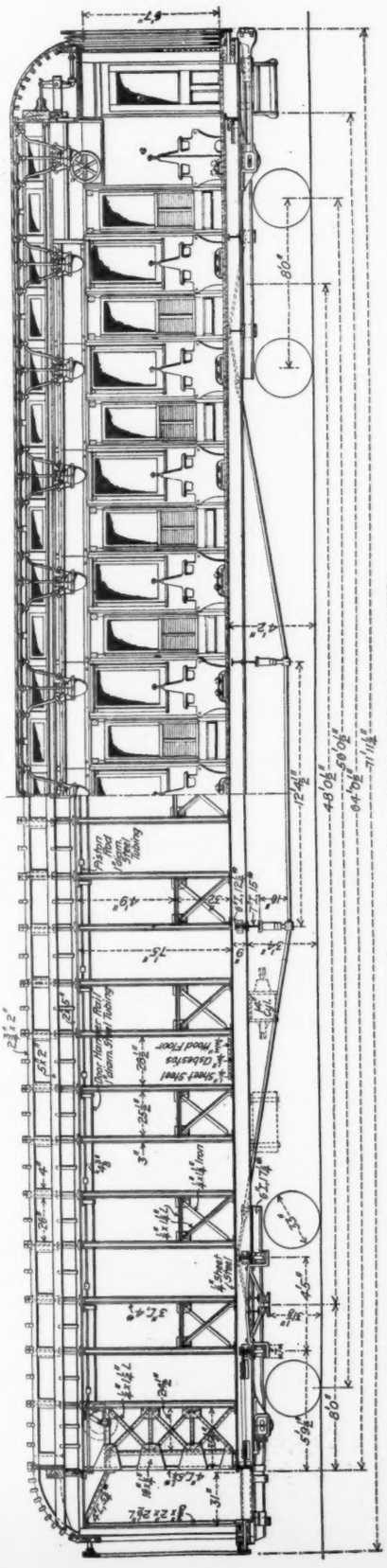
The upperframe is constructed of 3 in. 4 lb. channels with solid forged ends, which are riveted at the bottom to the top flanges of the side sills, and at the top to an iron plate 4½ by ½ in. which extends in one piece throughout the length of the car and the vestibules. The channels are spaced to form the window and door posts, and are set back to back 2 ins. apart so as to form hollow side walls, within which the doors slide when opened and closed. Below the windows a girth brace of 1¼ in. angle is riveted to the posts with gusset connections, to which the diagonal bracing of 1¼ in. angle and 1¼ by ¼ in. flat steel is riveted; this bracing at the lower end is shaped to form a foot, which is riveted to the lower part of the channel post and to the top flange of the side sill, thus reinforcing the post in its connection with the sill and forming a braced panel between each of the side-door openings. The corner posts consist of two 4 in., 5¼ lb. channels set transversely on the side sills and spaced 11 ins. apart. On the outside and inside of these posts four triangular gussets of ¼ in. by 15½ in. steel plate are riveted to the flanges, tying them firmly together; the corner posts are riveted securely to the side sills and to the upper plates with angle connections. The space between the corner posts and the adjoining side-door posts is braced with a double set of diagonal bracing, formed of 1¼ in. angles in three vertical panels and riveted to the gusset connections. Tnis arrangement of corner bracing gives stability to the upper frame and forms a strong collision bulkhead. Across each end of the car the corner posts are connected by ¼ in. gusset plates to 5 by 4 by 7-16 in. angles and support oak end plates, to which are secured the side arms for the buffing mechanism of the upper portion of the vestibule diaphragm plate. Diagonal braces of 4 in., 5¼ lb. channels are riveted to corner posts and to the extreme end at side plates, which extend beyond the corner post of the body of the car to the corner post of the vestibule carried by the platform end sill. The vestibule corner posts are further reinforced by upright angles ⅜ by 2 by 2½ in. with flanged ends, which are bolted to the platform sills and at their upper ends riveted to the side plates and the end braces. The carlines are of ⅜ by 2 in. iron and are placed directly over each set of side-door posts, each carline resting directly on the side plates and secured thereto at each end by four ½ in. rivets, which pass through the forged foot of the carline, the plate and the forged ends of the channel door posts tying them all securely together. There is thus formed a continuous connection of metal framing throughout the entire body of the car.

An unique method of securing the exterior and interior finish to the metal frame has been adopted. Within the hollow of the channels forming the posts of the side-doors and windows strips of hard maple, 1¼ ins. thick and neatly fitted to the channels, were placed before the posts were assembled; the channel posts were then placed in a chuck upon the bed of a planer with the maple filler upwards, and with a specially designed tool the upper edges of the channel flanges were split to a depth of 3-16 in., and the inner portion of the flanges rolled down cold and turned over onto the filler, compressing and firmly enclosing it within the channel walls without the use of screws or bolts, thus making the filler an integral part of the channel and affording a secure and permanent foundation for attachment in the usual manner of the exterior and interior finish. A secondary system of continuous horizontal bracing extends throughout the walls of the car, adding materially to the resistance offered to a raking, corner or end thrust above the level of the floor. The roof is of 13-16 in. poplar, nailed to the strips in the usual manner. The floor is laid in three courses; first the steel plates forming part of the underframe, upon which is laid over the entire surface a covering of asbestos ¼ in. in thickness, and upon this a light flooring of wood is laid crosswise in tongued and grooved strips, and bolted to the steel floor underneath. The exterior finish is of poplar sheathing in vertical tongued and grooved strips, 2½ in. in width; the interior finish is of mahogany panels inlaid with delicate border design in marquetry, and is continuous throughout the walls and the vestibuled ends of the car.

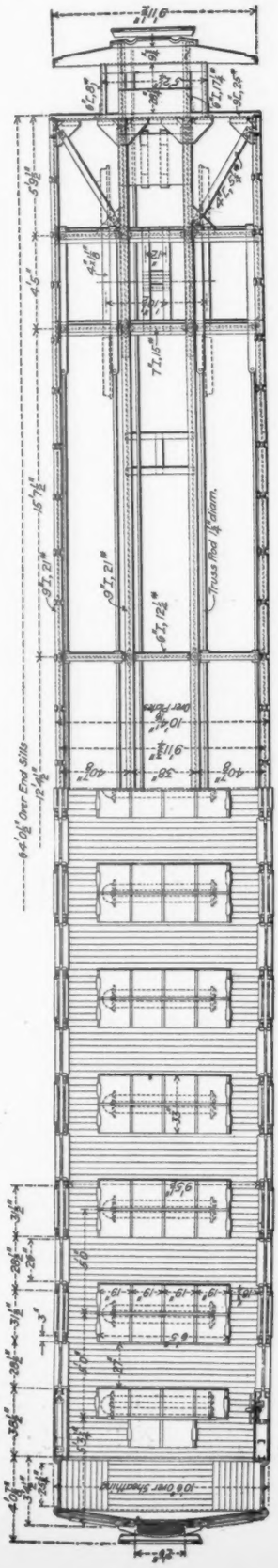
All of the floor space of the car including vestibules is available for passengers and the vestibule doors are arranged to permit of passing from car to car in the trains. The platform traps open against the ends of the car and the vestibule side

doors swing across the ends of the slide aisles, serving as barriers for the protection of passengers. The vestibule entrances and steps are provided in order to permit the use of the cars in excursion service. They are not required in the regular suburban service.

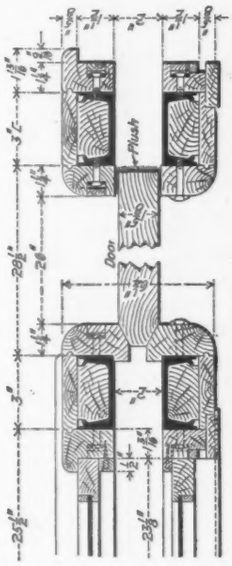
The seats are of an entirely new design, in bench form, arranged transversely in sections, each section seating eight passengers. They are constructed throughout of mahogany, with straight backs 42 in. high, provided with swell panels for back rests. No upholstering is used. The seat bottoms of solid mahogany are of molded form, mounted on trunnion bearings in front and supported on springs in the rear; each passenger having an independent seat separated from adjoining seats by short arms. These seats are designed to discourage "sprawling." They are most comfortable when the occupant is sitting upright in a position which economizes space. This is an important new principle in suburban car seating. There are twelve sections of seats, with two additional seats at each end of the car, making a total of 100 seats. Between the seat ends and the walls on each side of the car is an



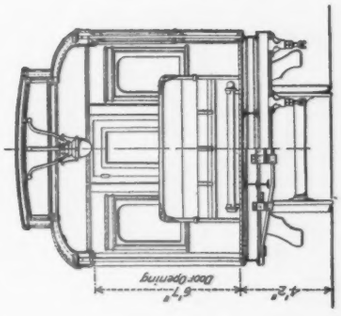
HALF LONGITUDINAL SECTION AND SIDE FRAMING.

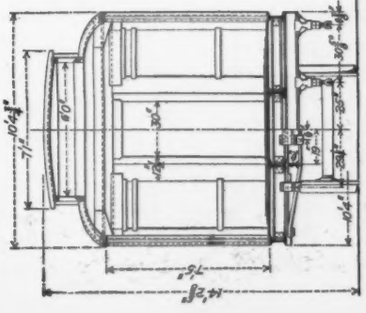


HALF FLOOR PLAN AND FRAMING.



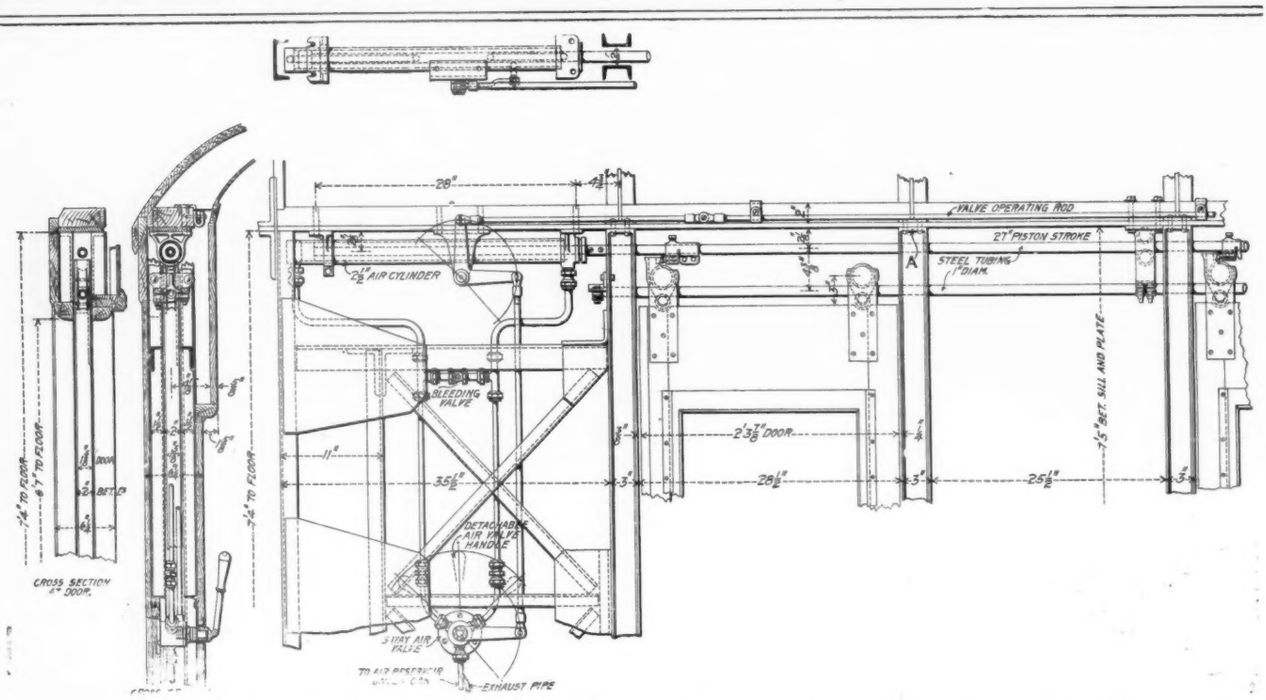
SECTIONS OF DOOR AND WINDOW FRAMING.





TRANSVERSE SECTIONS.

STEEL FRAME SIDE DOOR SUBURBAN CARS—ILLINOIS CENTRAL RAILROAD.

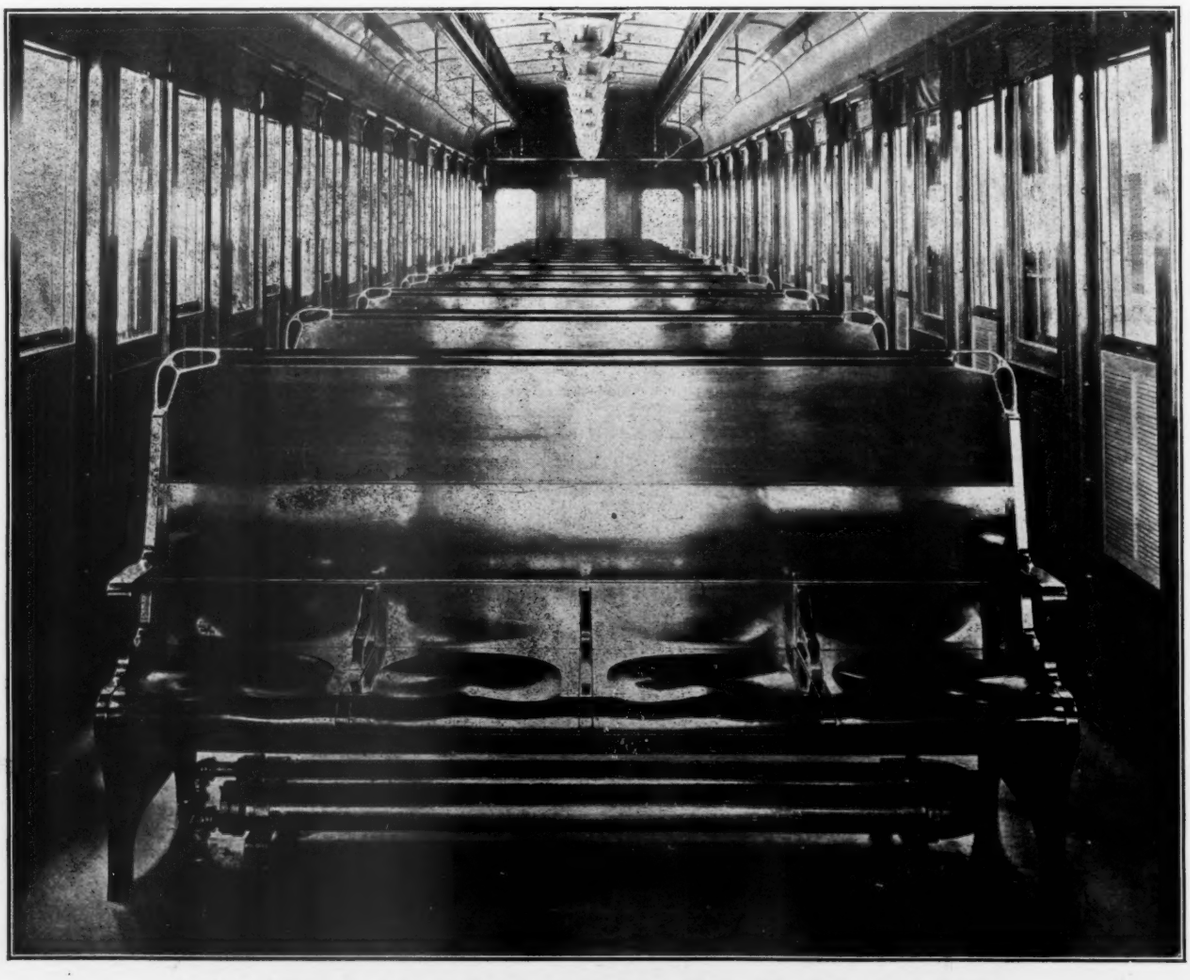


DETAILS OF DOOR OPERATING MECHANISM. (METHOD OF UPSETTING ENDS OF CHANNEL POSTS IS SHOWN AT A).

aisle 18 in. in width, extending the entire length of the car, connecting with the vestibule area and affording a passageway on both sides throughout the length of the train.

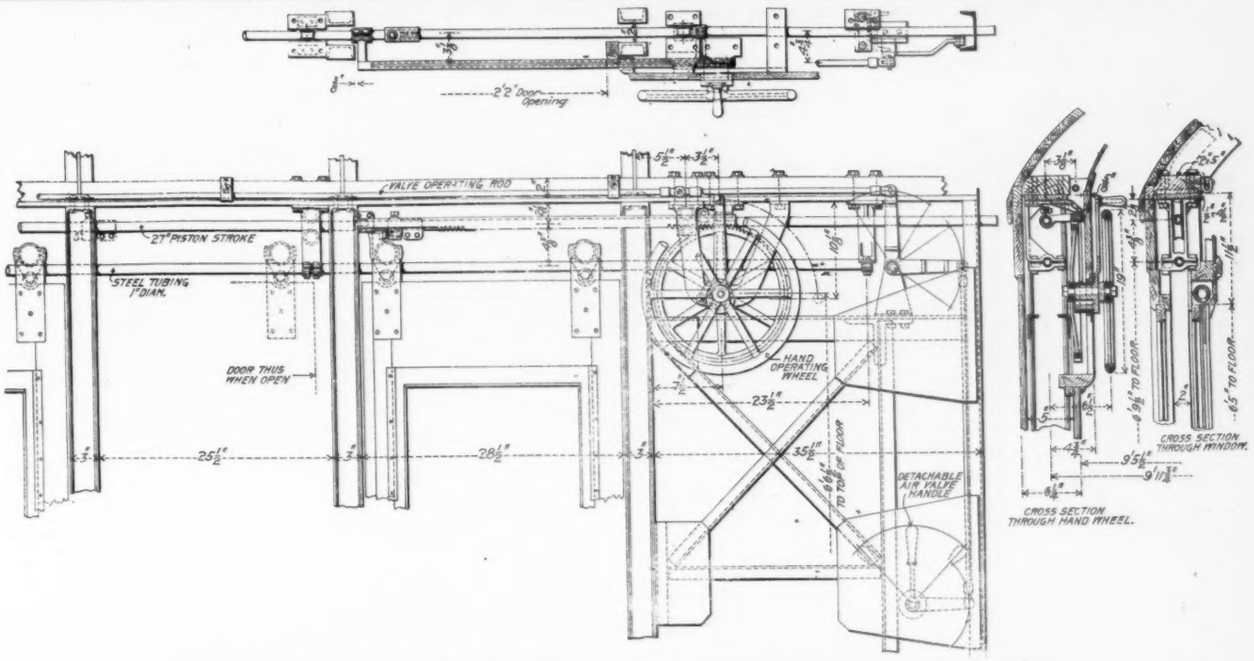
To give good light the glass is carried to a height of 6 ft. above the floor. These cars have the Pintsch light, with eleven three-burner lamps, making a total of 450 candle-power for each car. They are beautifully lighted and this is an object lesson in the illumination of suburban equipment.

These cars are carried on the I. C. R. R. Standard, four-wheel passenger equipment trucks, with 33 in. rolled steel wheels and 5 by 9 in. steel axles. They are equipped with Standard steel platforms and couplers, and the Sessions friction draft gear.



INTERIOR VIEW OF CAR, SHOWING MOULDED-FORM SEATS AND AISLE ARRANGEMENT.

STEEL FRAME SIDE DOOR SUBURBAN CARS—ILLINOIS CENTRAL RAILROAD.



DETAILS OF DOOR-OPERATING MECHANISM, SHOWING HAND-WHEEL AUXILIARY APPARATUS.

A novel method of attaching the draft rigging to the car has been adopted in consequence of the distance, 38 ins., between the center sills of the car. This consists of a steel plate, 2 ft. 5 ins. by 3 ft. 6 ins. by ¾ in., which is placed between the main sills of the underframe and the sub-sills of the platform and bolted through their flanges with twenty-four ⅝ in. bolts, accurately turned to reamed holes with a driving fit.

The weight of the car body is 61,400 lbs., and of the trucks 23,200 lbs., making a total of 84,600 for a seating capacity of 100 persons. Mr. Sullivan believes that this may be materially reduced without sacrificing strength.

In this system of construction the door operating devices constitute an element of vital importance. The accompanying illustrations show the entire operating mechanism, including the air cylinder for operating the doors at one end and the hand mechanism at the other end, for use whenever the supply of compressed air is cut off.

The air valve may be operated from either end of the car by means of the long valve operating rod shown on the drawing. This admits of the trainman working the doors from either end, which is quite a necessity with the method of having the collections made upon the train. The hand mechanism operates from one end of the car only, which is of less importance as it is but seldom used, the pneumatic apparatus working very successfully. The bleeding valve shown just below the air cylinder opens communication with the atmosphere from each end of the cylinder and equalizes the air pressure. The use of this valve is made necessary because in normal operation the full air pressure is against the piston either on the one side or the other, as the air pressure is relied upon to lock the doors by holding them tightly closed.

Whenever it may be necessary to cut out the air, the main air valve is placed on lap, which leaves one end of the cylinder containing air at full pressure, which will prevent the hand apparatus being used. This pressure is reduced by the exhaust of the bleeding valve and permits the piston to move freely in the cylinder when the hand apparatus is used. Each door cylinder is supplied from an auxiliary cylinder under the floor of the car, the pressure in which is maintained by a branch pipe from the train line in which is placed a check valve which closes automatically when the train line pressure is reduced in applying the brakes. The exhaust from the main air valve for operating the doors is carried through the floor of the car.

The different valve stems are flush with the interior finish of the car and present much the same appearance as the locks on the upper berths of a Pullman car. All of the door operating mechanism is contained within the walls and no part of it is visible to the passengers except the brass hand wheel and the lever which is used for throwing it into and out of gear, this being accomplished by a cam movement which requires a sweep of the lever of about 45 degrees. The clips on the piston rod which engage the door hangers and close the doors, are fitted with springs having a compression of about three-quarters of an inch. This spring movement equalizes any variation there may be in the setting of the clips, so that the cylinder pressure is distributed equally on all the doors.

The engraving shows the apparatus set for what is called its "permissive" operation, that is, the doors are closed and locked and held closed by air pressure with one movement of the piston, and released, but not opened by the other movement of the piston. This arrangement permits of any of the doors being opened by the passengers from either the inside or the outside of the car, and saves the necessity of opening all 12 doors at places where only one or two passengers may wish to enter or leave the car. This is the plan adopted for the winter season, and in the summer season, when there is no objection on account of weather conditions to opening as well as closing all of the doors at every stop, positive working is provided by merely mounting another clip on the piston rod immediately in front of the door hanger, so that the door is carried forward and back with each movement of the piston rod. Experience will determine which of these methods will be the more practicable.

The guide rollers for the piston rod are spaced five feet apart and mounted on roller bearings. The door hanger rollers are mounted on ball bearings. The piston rod, also the roller which carries the door, are made of cold drawn steel tubing, perfectly smooth on the outside, and the rollers are accurately turned to fit the tube, so that there is very little friction and the doors work very smoothly. The doors are suspended from the upper rollers and hang free, being guided at the lower end by a groove in the threshold, which holds them in line. The piston rod is continuous, being about 64 feet in length and made of tubing in jointed sections of about 18 feet in length. The tubing used for the door rail is cut in lengths of five feet and mounted so that the rail of any door may be removed without interfering with the rails of the other doors. The door mechanism is complete for each side of the car, one side being a duplicate of the other, and they are operated independently of each other.

NEW LOCOMOTIVE AND CAR SHOPS.

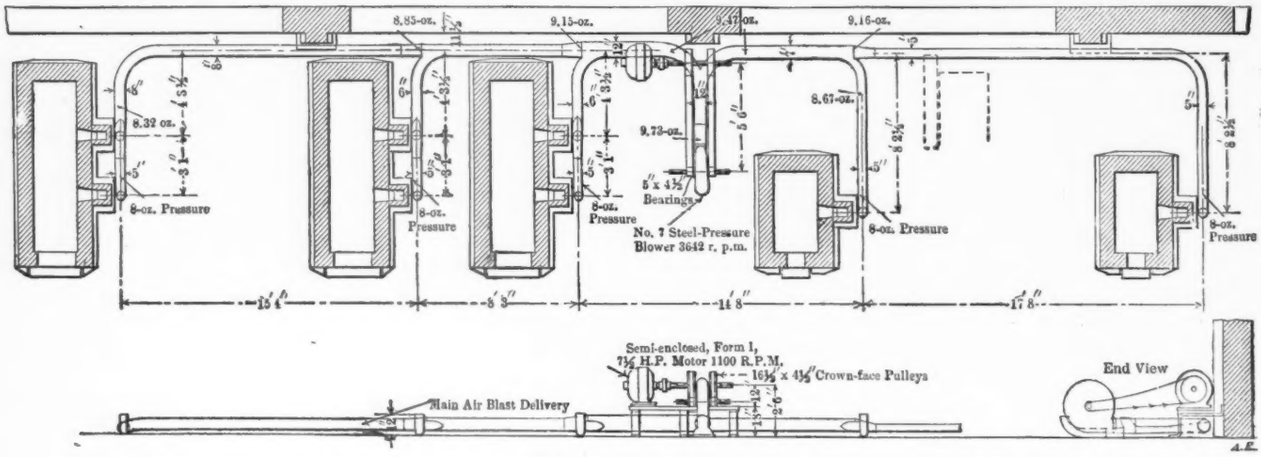
COLLINWOOD, OHIO.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

XI.

PRESSURE-BLOWER SYSTEM FOR OIL FURNACES.—THE SCRAP PLATFORM.—A PNEUMATIC DRIVING-BOX CRANE.

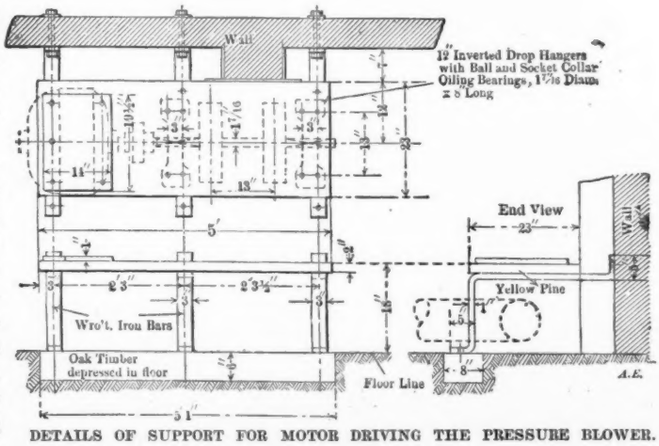
In the description of the fuel oil furnaces in use at the Collinwood shops, presented in the previous issue, mention was made (see page 335, September, 1903, number) of the fact that each separated group of furnaces has an independent motor-driven pressure-blower outfit for supplying the 8 ozs. of air pressure that is required at the tuyeres of the Ferguson oil furnaces. Seven pressure-blower equipments were installed in the various buildings, so as to avoid the necessity of delivering the blast at long distances from the blowers and the excessive drops in pressure that would thus be incurred. In this article we present drawings to illustrate a typical pressure-blower system, which will also indicate the care that was taken in the designs to provide for the inevitable drops of pressure at elbows in the delivery pipe.



ARRANGEMENT OF THE MOTOR-DRIVEN PRESSURE BLOWER OUTFIT AND THE PIPING SUPPLYING AIR BLAST TO THE OIL FURNACES.
BULLDOZER DEPARTMENT OF THE BLACKSMITH SHOP.
COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

The air-blast system illustrated herewith is the one supplying blast for the forging furnaces at the south end of the blacksmith shop, which take care of the bulldozer work. As indicated in the engraving, five furnaces are here provided for, three large ones and two small, by a No. 7 American Blower Company steel pressure-blower, operated at 3,642 revolutions per minute. The air-blast delivery pipe runs from the fan through long-radius bends to the various furnaces, as shown, the fan being located as near a central point as possible. The sizes of the different sections of the pipe were carefully calculated so as to bring the resultant delivery pressures at the furnace tuyeres to the necessary 8 ozs. The blower, at the rated speed, delivers at a pressure of 9.73 ozs., the various drops in the different sections of pipe being indicated on the same in the engraving presented above.

The blower is driven by a 7½-h.p. Crocker-Wheeler constant-speed motor, operating at 1,100 revolutions per minute. A double-belt drive is used, one belt on each side of the blower. The motor and drive-pulleys are mounted upon a stand next to the wall, the details of which are of interest. The accompanying sketch at the right illustrates the construction of this stand, the position of the motor, pulleys and inverted hanger bearings being drawn in dotted lines superimposed upon the plan view. The stand is raised to permit the delivery pipe from the blower to pass underneath on its way along the wall. The arrangement of the stand, as well as of the blower and delivery pipe, is worthy of note for the economy of space effected thereby.



DETAILS OF SUPPORT FOR MOTOR DRIVING THE PRESSURE BLOWER.

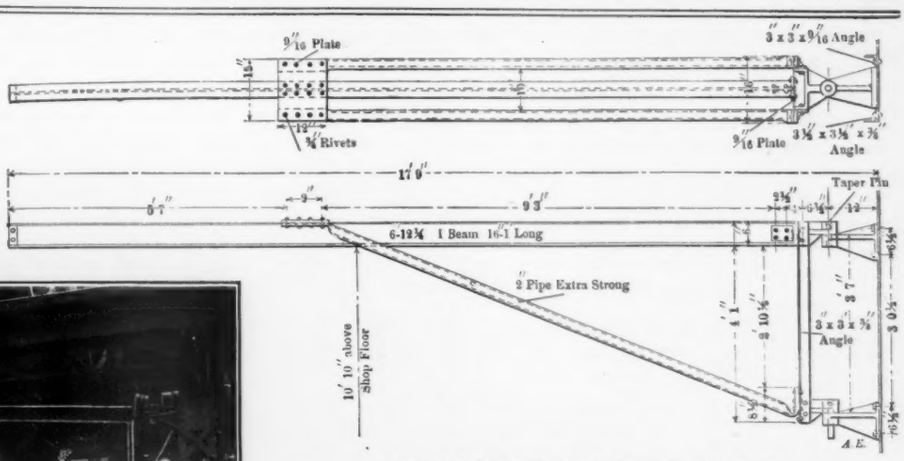
THE SCRAP PLATFORM.

The scrap platform at the Collinwood shops is a model for convenience and adaptability to local requirements, as well as the fuel oil system, described last month, is one of the most complete and best arranged plants for the purpose ever built. The design and equipment of these auxiliary departments were carried out by the officials in charge of the shop construction, to whom much credit is due for these details.

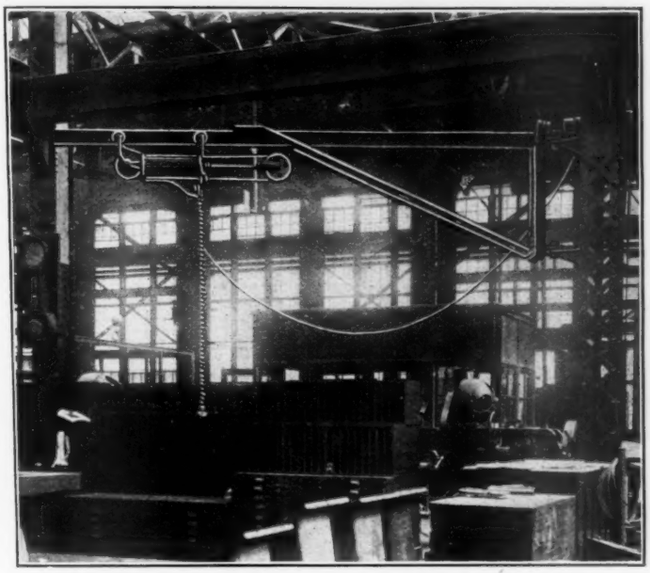
As will be recalled from the layout ground plan of the Collinwood shops, which appeared in the supplement for the October, 1902, issue of this journal, and also from the engraving on page 335 of the preceding issue, the scrap platform extends east and west and lies directly east of the bolt shop section of the blacksmith shop, between the brass foundry storehouse on the north and the iron storehouse on the south. It is served by a track on the north side, two tracks on the south and a cross track at the west end, so that scrap can be handled, after sorting, either into cars or west into the blacksmith shop. A half-tone on page 363 presents a view of the west end of the platform, showing the type of roof covering that is used for shelter. The scrap platform is 450 ft. long, 36 ft. wide and sets 4 ft. above the rail level of the side-tracks. The roof structure, which is illustrated in the engraving, is 330 ft. long, extending from the west end to within 88 ft. of the east end. The west end slopes with an easy incline to the yard level, with the exception of one section 20 ft. wide at the middle of the base of the incline, which sets level at a height of 21 ins. above rail level. The floor of the platform is of wood except at the bins, where it is paved with brick. The remaining general dimensions of this structure are made clear in the plan and cross-section presented in the engravings on the opposite page.

As may be noted from the plan view, 140 ft. of the west end of the sheltered portion is left open for piling scrap, cut-

ting and straightening bolts, etc. Beyond this begins a series of bins with sides 5 ft. high (each bin 10 ft. wide) and extending 190 ft. eastward; the first nine of these bins extend across the platform for holding long scrap, while the last ten are divided at the middle for short scrap. The east end of the platform (88 ft.) is left open for receiving fireboxes, tanks, etc.

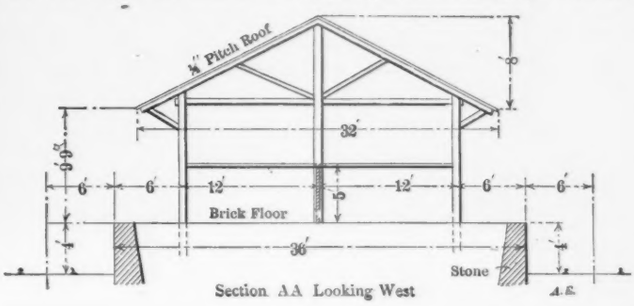


DETAILS OF CRANE FOR DRIVING BOX HOIST.

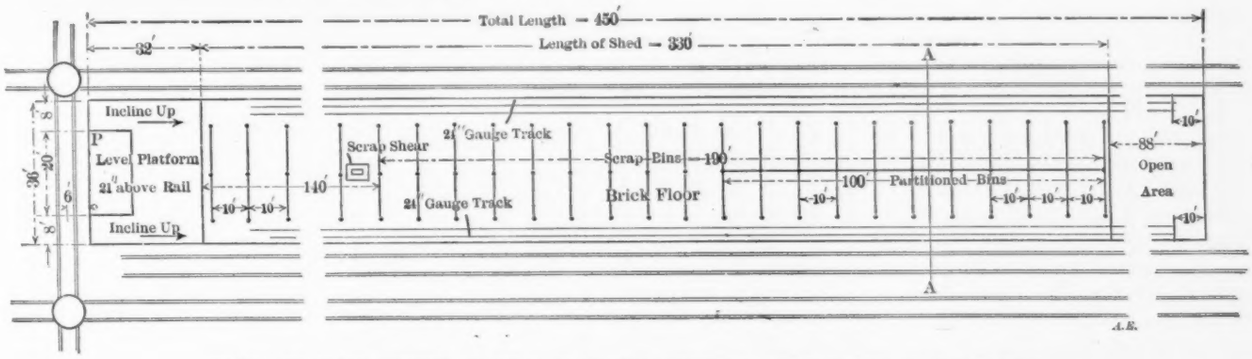


CRANE AND HOIST FOR DRIVING BOXES, IN THE DRIVING BOX SECTION OF THE LOCOMOTIVE SHOP. (See page 364.)

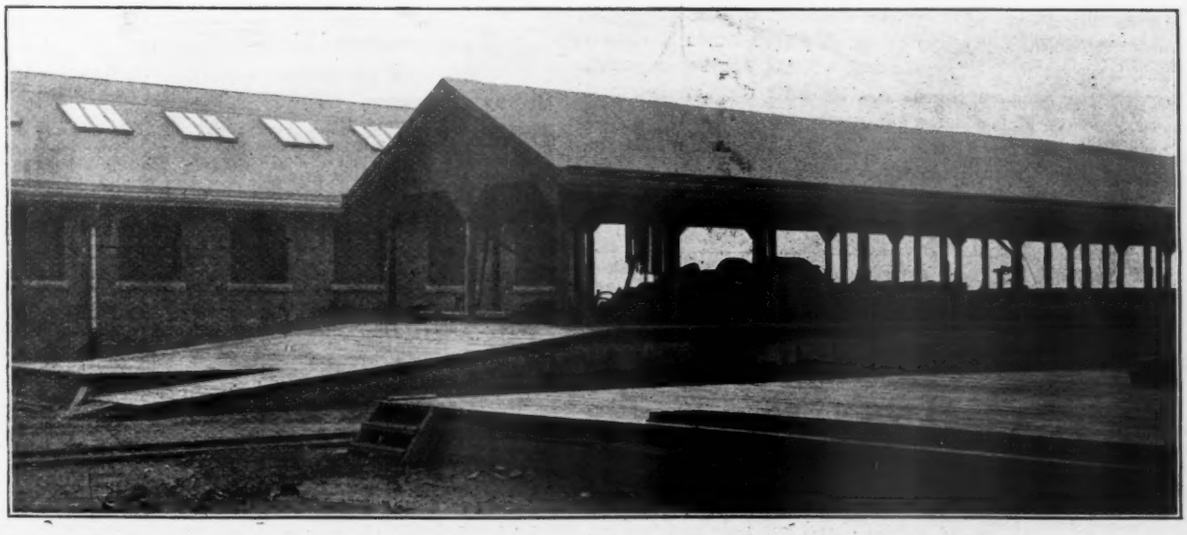
The bins are so located that after the scrap is sorted it may be loaded either directly onto cars without rehandling, or onto the cars upon the small narrow-gauge (24-in. gauge) track for



Section AA Looking West



PLAN AND CROSS SECTION OF SCRAP PLATFORM, SHOWING ARRANGEMENT OF SCRAP BINS.



VIEW OF WEST END OF SCRAP PLATFORM, SHOWING INCLINE LEADING DOWN TO GRADE LEVEL. (BRASS FOUNDRY STOREHOUSE AT THE LEFT.)

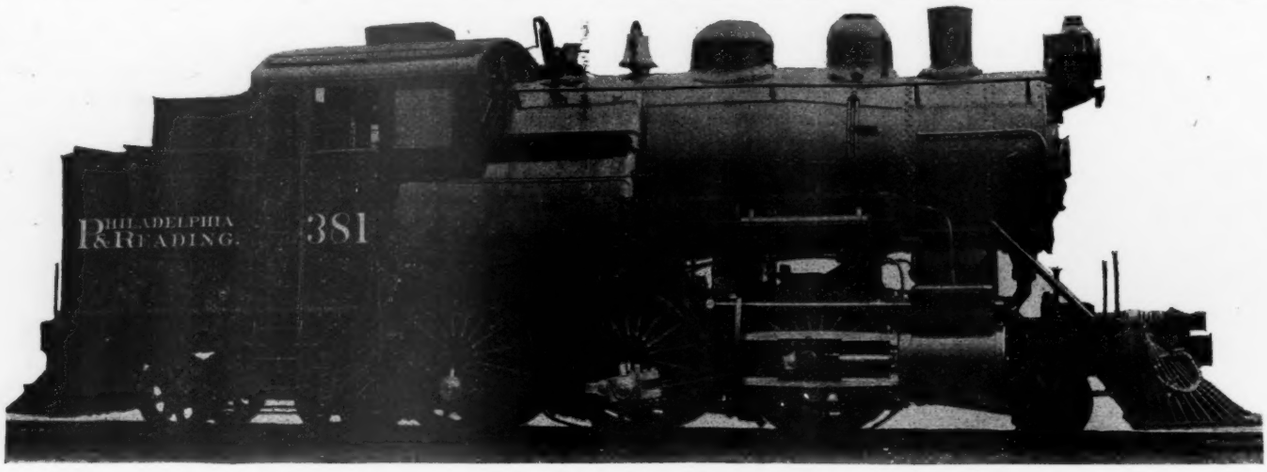
COLLINWOOD SHOPS.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

transferring or delivery to the blacksmith or bolt shops. The scrap shear and bolt straightener will be located near the bins at the point where the wrought-iron scrap will be sorted. From this point bolts and scrap for piling will go to the west end of the platform and the other scrap to the bins.

To the south of the scrap platform is situated the iron storehouse, in which all iron is stored for the blacksmith and bolt shops. Also all finished forgings and the brasses are to be stored there.

CRANE AND HOIST FOR DRIVING BOXES.

Two light portable cranes with a lifting capacity each of 700 lbs. have been fitted up for driving-box work in the locomotive shop at the Collinwood shops. These cranes have Curtis air hoists and are arranged so that they may be carried by the shop traveling crane to any of the main columns of the building, which are fitted with the brackets to receive them. These brackets are secured to the columns wherever driving-box work is done, and the air hoist is supplied with air by a swinging hose. This is an inexpensive "kink" which saves a large amount of labor. It represents an important principle in shop equipment in that the use of large overhead traveling cranes does not avoid the necessity of providing light pillar cranes for individual machines or departments.



LOCOMOTIVE FOR SUBURBAN SERVICE.—PHILADELPHIA & READING RAILWAY.

S. F. PRINCE, SUPERINTENDENT MOTIVE POWER. BALDWIN LOCOMOTIVE WORKS, BUILDERS.

SIX-COUPLED SUBURBAN LOCOMOTIVE.

PHILADELPHIA & READING RAILWAY.

Six suburban locomotives, for service into Philadelphia, have been completed for the Philadelphia & Reading Railway by the Baldwin Locomotive Works. They are of the double-end type and are in use on the Germantown & Chestnut Hill branch and on the Norristown branch between Manayunk and the Philadelphia terminal. The arrangement of the driving and truck wheels is like that of the New York Central suburban locomotive illustrated in this journal in April, 1902, page 115, but the Philadelphia & Reading engine has a four-wheel instead of a six-wheel truck under the rear end. These engines are fitted with slide valves. They have wide grates for anthracite coal of buckwheat size. A noteworthy feature of the boiler is in the very short tubes, 9 ft. in length. These engines will exert a tractive effort of 26,600 lbs. and should start trains very quickly. The cab of this engine is placed sufficiently far back on the firebox to bring the engineer and fireman together in the same compartment. A comparison of the principal features of this design and the two recent examples of locomotives for similar service on the New York Central and the Central Railroad of New Jersey, as given in the following table, may be convenient for reference:

THREE RECENT SUBURBAN LOCOMOTIVES.

Name of railroad	N. Y. C.	C.R.R. of N.J.	P. & R.
Number of road or class	1410	200	381
Builder	American	Baldwin	Baldwin
Simple or compound	Simple	Simple	Simple
When built	1902	1902	1903
Weight, engine total, lbs.	216,000	189,900	201,700
Weight on drivers, lbs.	128,000	129,000	120,860
Weight on leading truck, lbs.	.....	21,900	19,120
Weight on trailing truck, lbs.	.....	39,000	61,920
Weight of tender (loaded), lbs.	.....	Side tank	.....
Wheel base, driving, ft. and ins.	15-0	14-0	12-6
Wheel base, total, ft. and ins.	35-9	31-8	30-9
Driving wheels, diameter, ins.	63	63	61⅝
Cylinders, diameter, ins.	20	18	20
Cylinders, stroke, ins.	24	26	24
Heating surface, firebox, sq. ft.	162	96.6	156.3
Heating sur., arch tubes, sq. ft.	.....	43.0	.....
Heating surface, tubes, sq. ft.	2,275	1,695.0	1 825.5
Heating surface, total, sq. ft.	2,437	1,834.6	1,981.8
Firebox, length, ins.	93	109	94
Firebox, width, ins.	97⅞	72	105
Grate area, sq. ft.	62.1	54.5	68.5
Boiler, smallest diameter of, ins.	70	60	66
Tubes, No. and diameter in ins.	365-2	249-2	447-0
Tubes, length, ft. and ins.	12-0	13-0	9-0
Steam pressure, lbs., per sq. in.	200	200	200
Reference in American Engineer and Railroad Journal	April 1902 P. 115	June. 1902 P. 200	Oct., 1903

The following tables give the ratios and a record of the leading dimensions of the Philadelphia & Reading design:

Heating surface to cylinder volume	= 226
Tractive weight to heating surface	= 61.
Tractive weight to tractive effort	= 4.54
Tractive effort to heating surface	= 13.43
Tractive effort x diameter of drivers to heating surface	= 824.
Heating surface to tractive effort	= 7.4%
Total weight to heating surface	= 101.8

SIX-COUPLED SUBURBAN LOCOMOTIVE.

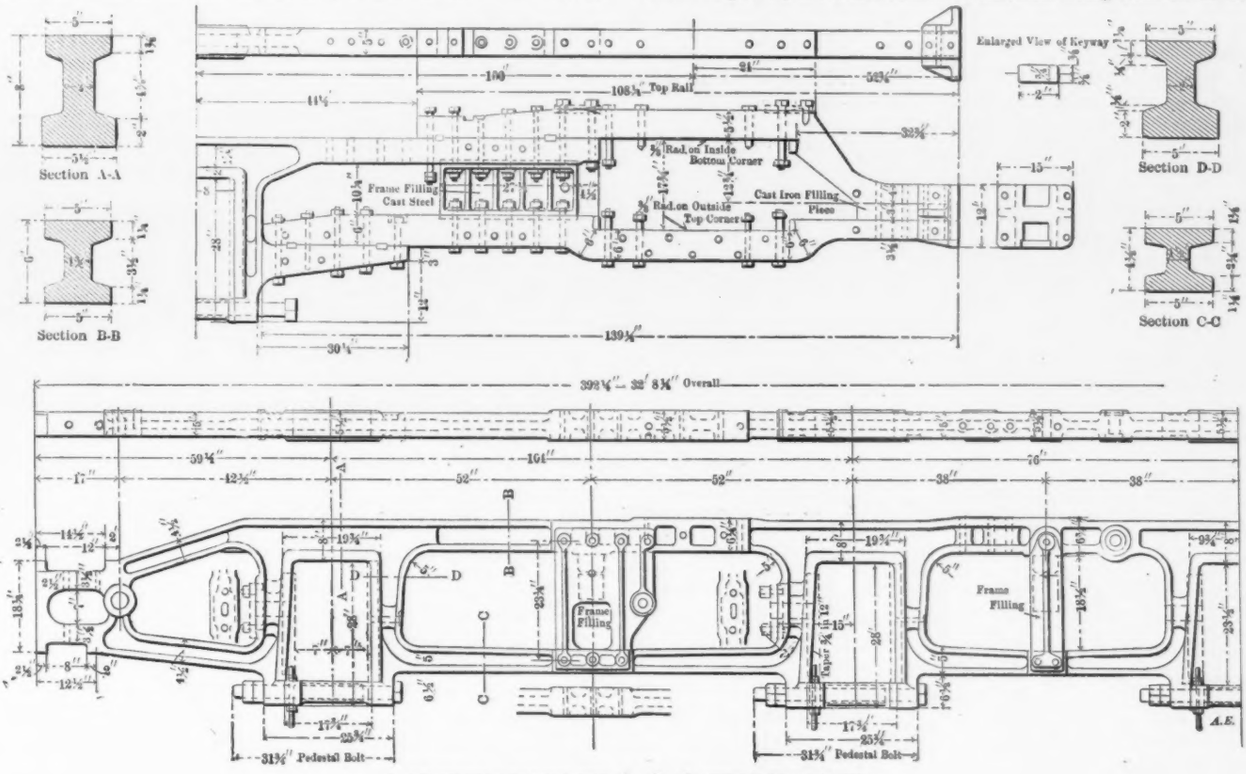
PHILADELPHIA & READING RAILWAY.

Gauge	4 ft. 8½ ins.
Cylinder	20 x 24 ins.
Valve	Balanced
Boiler—Type	Wagon top
Diameter	66 ins.
Thickness of sheets	11-16 and ¾ in.
Working pressure	200 lbs.
Fuel	Anthracite buckwheat
Staying	Radial
Firebox—Material	Steel
Length	94 ins.
Width	105 ins.
Depth	Front, 59¼ ins.; back, 46⅜ ins.
Thickness of sheets. Sides, ⅜ in.; back, ⅜ in.; crown, ⅜ in.; tube, ½ in.	
Water space	Front, 3½ ins.; sides, 3½ ins.; back, 3½ ins.
Tubes—Material	Iron
Wire gauge	10 B. W. G.
Number	447
Diameter	1¾ ins.
Length	9 ft. 0 in.
Heating Surface—Firebox	156.3 sq. ft.
Tubes	1.825.5 sq. ft.
Total	1,981.8 sq. ft.
Grate area	68.5 sq. ft.
Driving Wheels—Diameter outside	61⅝ ins.
Diameter of center	54⅝ ins.
Journals	8½ x 12 ins.
Engine Truck Wheels (front)—Diameter	30 ins.
Journals	6 x 12 ins.
Engine Truck Wheels (back)—Diameter	33 ins.
Journals	6 x 12 ins.
Wheel Base—Driving	12 ft. 6 ins.
Rigid	12 ft. 6 ins.
Total engine	30 ft. 9 ins.
Weight—On driving wheels	120,860 lbs.
On truck, front	19,120 lbs.
On truck, back	61,920 lbs.
Total engine	201,700 lbs.
Tank—Capacity	3,000 gals.
Coal	7,500 lbs.

CAST STEEL LOCOMOTIVE FRAMES.

DELAWARE & HUDSON COMPANY.

As a result of careful study of the failures of locomotive frames, Mr. J. R. Slack, superintendent of motive power, and Mr. G. S. Edmonds, mechanical engineer, of the Delaware & Hudson Company, have developed new designs with special reference to the action of cast steel in the foundry. Instead of casting frames of the form of wrought iron with rectangular sections throughout, this design distributes the metal in I sections, with curves of large radius as fillets, and the members are also tapered and the thickness of the webs are varied wherever this seems to offer advantages. The particular frame illustrated in this engraving is that of the 4—6—0 type



CAST STEEL FRAMES FOR 4—6—0 TYPE LOCOMOTIVE.
DELAWARE & HUDSON COMPANY.

locomotive illustrated on page 285 of the August number of this journal. This design represents the latest and most satisfactory development of this principle on this road, and it is reasonable to expect improved service from a careful distribution of the metal. Mr. Edmonds has recently read a paper on the subject of locomotive frames before the Pacific Coast Railway Club, which is interesting in this connection.

It is evident to those who have devoted the greatest amount of study to the subject of frame failures that not only must the design of the frames be correct in detail, but that the frame structure as a whole may need bracing in a new way in order to prevent the deflections which result in breakage. The combination of correct design with the necessary bracing should result in a very greatly needed improvement. The results of some interesting experiments upon the deflections in locomotive frames will soon be recorded in this journal.

A RATIONAL METHOD OF DESIGNING LOCOMOTIVE FRAMES.

From the paper by Mr. Edmonds the following paragraphs are abstracted:

One thousand pounds unnecessary weight in a pair of engine frames, on a road with 1,000 engines, same making 50,000 mileage per year, in life of said engines, assuming 15 years, means 375,000,000 tons hauled one mile. This, at the arbitrary figure of $.0002 as maintenance and transportation cost of one ton one mile, gives $75,000, since we can assign, assuming 1,500 as train tonnage, five of these engines, for one entire year, to the movement of this extra frame load.

For material, hammered iron has the favor of the majority, excepting in cases of very heavy forgings, where cast steel is employed. Usually the section used is the same, whether of iron or steel. This may be accounted for by the commendable spirit of standardization prevalent at this period, but just why the same line of reasoning should hold with new design is not as apparent.

While experimental with some, other roads have used cast steel to a considerable extent, with variable experience.

Compared we note:

1. Hammered iron has the distinctive advantage of being readily welded. Investigation as to results with steel finds some things to be desired. This may in part be accounted for by lack of tools of sufficient power, the constituents of material being such as to note permit of its being reduced to as plastic a condition as the iron, requiring a considerably greater force to unite.

2. Uncertainty of product meets claims on both sides, for, while with steel, blowholes and honeycombing will creep in, ofttimes being hidden in the heart of the section, equally true, from time to time, with the large amount of steel now being used in locomotive and car construction, the difficulty of confining scrap to wrought iron cannot but increase. Failures in many instances are correctly attributable to these sources.

3. In design, with hammered iron, we are practically limited to the rectangular section, whereas with cast steel it may be molded to meet the most exacting conditions.

In these days, with the demand for greater power in proportion to weight, the doing away with the dead load and transferring its equivalent parts where it may be of value, viz., boilers and cylinders, this feature points to a more extended use of material in the future.

Raised bosses at parts which need to be finished reduce this portion of the cost a considerable extent, such being applicable to all designs in steel, irrespective of the section. If, as is believed by some, the outer unfinished section of a steel casting is stronger than the interior, a sub-advantage is also secured.

Analyzing, we know that:

1. A web section gives us higher moments of inertia per unit weight than any other.

2. A frame casting is such that the use of coring must be eliminated, else first cost will be excessive, with possibilities of shifted cores.

3. The second condition reduces the number of available web

sections to channel and I sections. When we consider the problem of molding, with shrinkage effects, the latter seems decidedly the more desirable of the two. The comparative thinness of the I casting allows of a ready and careful examination by the inspector, whereas with the rectangular section, ofttimes the outer surface covers a multitude of sins, discovered only when failure of part discloses interior honeycombing. Hence, while of higher factor of safety if sound, the uncertainty of the material, for above reason, favors the I section.

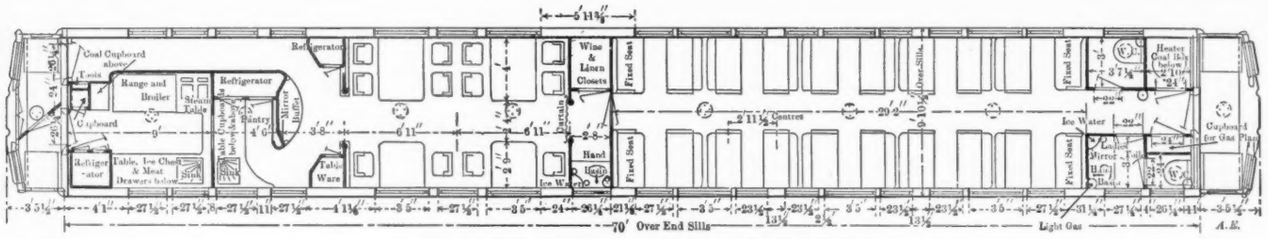
Lack of time prevents a more exhaustive treatise of the subject, which many others could treat to better advantage than the writer, yet, while limited in its scope, four ends are sought, the accomplishment of which marks the attainment of the purpose of the paper, viz.:

1. The advancement of the design of the locomotive as made by a rational method of frame design.

2. The presentation of the necessity for more than one set of specifications to govern the cast steel as used on the locomotive and tender.

3. The adoption, if possible, of standard sets of specifications for cast steel on all roads, reducing the problem of production to the manufacturer to a minimum.

4. Awakening of a discussion as to whether or no we do well in adhering to the rectangular section, or will the more exacting conditions soon to be met mark its passing to some other form?



COMBINATION DINING CAR AND FIRST-CLASS COACH.
CANADIAN NORTHERN RAILWAY.

COMBINATION DINING CAR AND COACH.

CANADIAN NORTHERN RAILWAY.

Through the courtesy of the mechanical officers of this road a floor plan of one of their new combination dining cars has been received. In a 70-ft. car, besides seating accommodations for 40 persons in the coach seats, room is found for 12 table seats, a 9-ft. kitchen and a 4-ft. 6-in. pantry. These cars were designed to run west of Winnipeg, where the country is sparsely settled and yet where dining-car service is required. By means of these cars an extra coach on a train and the expense of large and heavy dining cars are saved. The drawing shows the disposition of the floor space.

THE PROPORTIONS OF MODERN LOCOMOTIVES.

Those who are interested in the development of the American locomotive should procure copies of the paper read last month before the New York Railroad Club by Mr. L. H. Fry. It records a painstaking comparison of over 250 locomotives with respect to the factors of adhesion, steam consumption, combustion conditions and efficiency of design. Mr. Fry has placed before the club the complete record of his work in this connection, which was concisely summarized in his article in this journal last June. From this paper the tendencies in modern design may be intelligently studied.

While it is impossible to draw definite conclusions from averages derived from individual locomotives between which wide variations exist, the classification used in the tables permits of more valuable comparisons than were possible before.

Mr. Fry, in discussing his "BD" method of comparing locomotives by the ratio of tractive effort multiplied by the diameter of driving wheels and divided by the heating surface (described in his article in this journal in October, 1902, page 313), says: "The objection may be made to the use of a factor of this sort that it does not take any account of the relative value of heating surface. A well designed boiler may, under similar conditions, be capable of evaporating considerably more water per square foot of heating surface than can a poorly designed boiler." This at once raises the question, "What constitutes a well designed boiler?" This is one of the most important questions of locomotive practice to-day.

There seems to be a very great difference in effectiveness of heating surface in different locomotives. For example, two well-known passenger locomotives in Mr. Fry's list which are of the same type, of almost the same total weight, and in apparently similar service, have not by any means the same heating surface. In fact one has 33 per cent. more than the other. Both steam freely and both do good work. These two locomotives represent entirely different ideas in design. One stands for a selection of an amount of heating surface which will fit the other factors of design in accordance with ratios or relationships which have been found satisfactory in previous classes of engines. The other locomotive stands for the maximum heating surface which could be provided. This shows a difference of opinion which seems remarkable. For several years the good work done by foreign locomotives, especially French, with heating surfaces much smaller than ours, has caused comment. It is unquestionably true that a boiler cannot have too much heating surface, providing it is all effective, but there is reason to raise the question whether free circulation has not in many cases been sacrificed in order to secure large surfaces. Where to draw the line between circulation and heating surface is a nice question and one which is now being earnestly studied by those who are having the most trouble with boilers. It is to be hoped that the trial of a French locomotive, soon to be carried out in this country, will throw some light on this subject.

While the averages drawn by Mr. Fry show rather uniform general tendencies, such individual differences as those mentioned stand out prominently enough to indicate that a great deal yet remains to be learned with reference to boiler proportions. The figures in the paper referred to should be plotted and the locomotives representing the high and low points in the curves should be compared as to performance. Road tests of a half-dozen passenger and perhaps a less number of freight engines, under suitable and similar conditions, could be made without great expense. It seems strange that some big railroad does not undertake to learn the facts which are so greatly needed.

There is a rapidly growing sentiment in favor of the use of alternating-current apparatus for the electrical equipment of railroad repair shops, as this type has many valid claims over direct-current apparatus, and the rapid introduction of practical mechanical variable speed mechanism or the use of magnetic clutch speed changes makes the induction motor as flexible and available for variable speed as the direct current motor. The principal advantage of the alternating-current system is the high working voltage possible, and corresponding economy in weight of wire, with long distances. The electric requirements of most railroads in their new power stations for shops involve electric lighting for distant stations and yards, and a high voltage is necessary under such conditions.—L. R. Pomeroy.

COMPARISON OF HEADLIGHTS: OIL, ACETYLENE AND ELECTRIC.

The following figures and statement were presented by Mr. Wm. McIntosh in a topical discussion before the recent convention of the Master Mechanics' Association.

It appears that of the 41,300 locomotives in the United States, fully 37,450 still retain the oil lamp and ordinary planished reflector for headlights. About 3,200 have electric headlights, using the ordinary reflector, and generating electricity with small steam motors of the reciprocating or turbine type—the latter rapidly coming into favor.

There are some 1,650 acetylene generators now in use for generating gas for locomotive headlights, which are usually equipped with the regulation sheet iron case and planished reflector, the remainder with what is known as the "Lens Mirror" or "Searchlight Reflector," which is much smaller than the planished reflector, and vastly more powerful and reliable, occupying a much smaller casing, which is usually formed cylindrically, and therefore, much more compact and durable. The reflector itself being of glass, and practically indestructible, requires only occasional wiping off to be in condition for service indefinitely. It would seem probable that with these advantages it should soon succeed the old type of lamp.

The old oil lamp when compared with the new types of acetylene and electric headlights, cost much less for its supply of oil than the others do for carbide or steam, yet when the costs of operating it are counted carefully, including cleaning material, wicks, chimneys, and burners, with the frequent losses from burning up, does not prove to be so economical after all; and it falls far behind in the candle power of either acetylene or electricity, and failing also in reliability.

Acetylene gas, while costing more for its carbide than oil, does not require chimneys, nor expensive burners with wicks, and gives out several times the candle power of the best type of oil burning headlight, without bringing out criticism of its intensity.

The electric headlight is more expensive in the line of first cost; also in maintenance, owing to the motor and dynamo required to generate the current, and the amount of steam needed to operate it. The intensity of the light thrown out is objected to by some on account of the glaring properties, and tendency to affect the vision of engineer's approaching it; while others claim that these features are not seriously objectionable, and the advantages far outweigh them.

Below are presented some data regarding cost of maintaining the oil lamp in comparison with the electric and acetylene lights.

One road reports the cost of maintaining 450 engines with ordinary headlights for a period of one year as follows:

Name of Parts.	Number of Parts.	Total Cost.	Average Cost per Engine.
New headlights, complete	63	$1,249.50	$2.76 +
New interiors	36	408.00	.91
New burners	138	293.70	.65
New cases	6	7.00	.02 —
Reflectors replated and required	268	815.54	1.81 +
Buttons and other small repair parts	...	55.00	.12 +
Chimneys	6,396	533.00	1.18
Wicks	1,056	21.56	.05
Glasses	204	91.71	.20 +
Cleaner (boxes)	1,074	208.80	.46 +
Labor and material, repairs	...	286.66	.64
Grand total	...	$3,970.47	$8.82

The above road reports the comparative cost of operating oil and acetylene lights so far as the light producing medium is concerned as follows:

With kerosene oil, at 7⅝ cts. per gallon in tank lots, and with carbide at 3¼ cts. per pound in 100-lb. lots:

Cost of oil light per hour.....33-100 cts.
Cost of acetylene light per hour.....58-100 cts.

In presenting this statement it was suggested that a considerable saving could be effected by substituting the acetylene for the oil headlight, because of the possibility of eliminating a number of extras, not required with acetylene, but, used in connection with oil lights, as follows:

Replating reflectors	$815.54
Buttons and other small parts	55.00
Chimneys	533.00
Wicks	21.56
Cleaner	208.80
Total	$1,633.90

Another road reports tests covering oil, acetylene, and three different types of electric headlights as shown in the total below:

With cost of kerosene 14½ cts. per gallon, and with cost of carbide 5 cts. per pound:

Kind of Light.	Cost per 1,000 Engine Miles.	Relative Value of Light.
Coal oil	.1844 cts.	1
Acetylene	.4688 cts.	8
First—electric	.2821 cts.	50
Second—electric	.7109 cts.	50
Third—electric	.2533 cts.	50

This comparison is made on the basis of 16 hours light per 1,000 engine miles.

In summing up, it is apparent that the oil burning headlight has had its day, and must give way to better devices. It is an awkward affair at best, with its large housing shaking loose, and front glass that is often breaking; its abnormal capacity for using up chimneys, and wicks; the frequency of replenishing the reflector; the number of leaks that occur in its attached oil reservoir and connections; the fires that often develop, resulting in the burning up of the entire apparatus, and the care required, in the way of trimming and cleaning—these all combine to add to its unpopularity.

In former days when every locomotive, like Goldsmith's rood, maintained its man, or regular engineer, the oil lamp received the care and attention required to keep it in serviceable condition; but in these days of pooling and double crews, it is neglected, and generally presents a dilapidated appearance. It will be claimed, and truly, that the acetylene and electric lamps also require attention and renewals; but if supplied with "lens mirror reflectors," of the regulation diameter, and correspondingly small housings, which can be constructed on cylindrical lines, and largely of malleable or cast iron, furnishing the rigidity and endurance required, much better results should be obtained. The relative cost of the different types of headlights might be approximated at $25 for the oil lamp, $100 for acetylene, and $200 for the electric. And careful records will show, that but little, if any, economy will follow the use of the oil lamp, while the efficiency is largely in favor of electric or acetylene.

INTERNAL COMBUSTION ENGINES.

Confidence in gas engines is constantly increasing. Ten years or so ago the writer witnessed a test wherein the makers of the engine were called in order to insure the operation of the machine for a sufficient time to permit of taking the desired number of indicator cards. Now we may point to the fact that the City of Philadelphia is to rely entirely upon gas engines for the purpose of a new emergency fire system for the business district of the city. In England continuous runs of 138 days have been made by a gas engine without stopping.

In his paper on internal combustion engines read before the Master Mechanics' Association, Mr. Sanderson expressed the opinion that if the gas engine had begun its development before the steam engine, the latter would not have been developed at all. He is probably safe in this statement, for the gas engine has now attained an efficiency of operation which is higher than the theoretically perfect performance of steam.

The introduction of the subject before the Master Mechanics' Association is timely, and one does not need to be an enthusiast to clearly see the necessity for closely watching this remarkable progress. Leaving out of account the possible future application of the internal combustion engine to direct transportation, it has a sufficient field in other lines connected with railroad work now that the electric generator has become a necessity.

It would be a pity if the woeful loss of life in the recent Paris-Madrid motor car race should leave no trace of useful effect. From that fool-hardy performance may be seen the

possibility of running a 70-h. p. motor car a distance of 342 miles, over ordinary public roads, in 5 hours 13 minutes, on an average speed of about 66 miles per hour, which is the average schedule speed of the "Atlantic City Flier," for a distance of 55 miles. That this can be accomplished with these machines entitles the principle which they represent to attention as a possible factor in heavier transportation service. Speeds close to 90 miles per hour are already recorded for motor cars. Some recent ones have been equipped with motors of 110 h. p. In the race referred to, an ordinary touring car made the run of 342 miles at an average speed of 38 miles per hour, when fully loaded with passengers.

Without venturing a prediction in this connection the facts mentioned sufficiently justify the conclusion that the internal combustion engine is sure to occupy a place which cannot be filled by the steam engine.

In the matter of shop-power plants, especially where forging work is to be done, the time has arrived for considering gas producers and gas engines.

METALLIC PACKING.

Motive power officers who are not having trouble with piston rod and valve stem packings are exceptional. Packing is blowing, literally from one end of the country to the other, and the situation has become serious when wrecks occur because the leakage of steam obscures the view of engineers. It is expensive to renew metallic packing on a locomotive 20 times in 60 days, but this is being done. It is even impossible for these officers to fully appreciate how this subject is neglected by their own people and will not credit it until they are forcibly brought in contact with it. A little systematic care will save thousands of dollars in wear on piston rods, valve stems and packing rings. It is no more trouble to keep piston rods and valve stems steam tight than many other parts of the engine, yet they seem to cause more trouble than all the rest combined. The same packing used upon marine engines is absolutely steam tight, and it can be kept so on locomotives.

Probably higher steam pressures and increased severity of service which allows but little time for work at roundhouses accounts for some of the trouble. The pooling system has tended to remove the factor of personal interest in their engines on the part of the engineers, and in the old days of fibrous packing the men who ran the engines gave packing the frequent and faithful attention which it needed.

Nowadays, the metallic packing comes in neat packages ready to be thrown into place, and it is no one's special business to see that it hits the mark, that it fits the cup and the rod and that it receives the proper amount of the right kind of lubricant. Light engine oils are often used, and these do not stand the heat of the steam. Valve oil or some lubricant which will not evaporate or blow off is needed. In California crude fuel oil, which resembles tar, has been used successfully. In some places no oil whatever is used.

Some roads do not bore out the packings at all, others do not fit it to the rods, and as it is supposed to be, to a certain extent, self-adjusting, the fitting is sadly neglected. They even contend that packing rings as they leave the mold without being machined are as good as those machined. Why do not these same people contend that it is unnecessary to bore a cylinder or turn a piston? No wonder it leaks. Piston and valve rods should be ground accurately and not filed. They should be fitted up to definite sizes and the packing bored to suit. The cups should be fitted accurately to gauges and great care used to finish the sets of packing so that they will fit. This is a matter of grave importance, and the situation absolutely requires the attention of specialists who have made a study of packing and may be held responsible for the practice of an entire road. Such men should study their specialty at the works of the packing manufacturer and apply a systematic method at all roundhouses. There is no other way to fix this situation which is neither safe or creditable. "Rod packing cannot be satisfactorily handled with a shovel." Worse troubles than this have been overcome and "motive power officials will not long be excused for the neglect of this problem." These are the words of a well-known railroad officer. If metallic packing is given a fair chance it will do all that is required of it. The fact that there is a turning back a quarter of a century toward fibrous packings and that this is spoken of seriously as a remedy of present difficulties is a severe comment upon the situation.

ENCOURAGE THE WATER-TUBE LOCOMOTIVE BOILER INVENTION.

Locomotives may yet be fitted with water-tube boilers. This type of boiler offers special advantages for locomotive service and these are sufficiently important to justify every encouragement to those who are seeking to find a satisfactory way to design one.

In marine service it is held that, aside from the destructiveness of corrosion, the life of a Scotch boiler varies in inverse ratio to the number of times steam is raised. A water-tube boiler is not subjected to such severe distress from this cause and its parts are free to adjust themselves to rapid changes in temperature. In the locomotive boiler we have an aggravated case of distress because of frequent and even violent changes of temperature, to which a large proportion of boiler difficulties, especially the leakage of tubes, is undoubtedly due.

As to the matter of rapid steam raising with water-tube boilers, the following, from a paper by Mr. Wm. A. Fairburn, read before the Society of Naval Architects and Marine Engineers, is noteworthy:

"The Babcock & Wilcox boiler, of a small tube type, in H. M. S. Sheldrake, when tested by the British Admiralty, gave the following results: Steam raised to working pressure from water at 70 degs. in 23 minutes. Period of time from fires being drawn and water blown out to drawing tubes, 24 minutes.

"Representatives from the United States Navy Department, when making a test of the Babcock & Wilcox boiler built for U. S. S. Alert, found that the working pressure of the boiler, 225 lbs., was reached 26¾ minutes after the fires were lighted. With a similar boiler built for the U. S. S. Cincinnati, 215 lbs. steam pressure was obtained in 12 minutes and 40 seconds after the fires were started."

Such rapidity of "firing up" would be appreciated to-day in the roundhouse. As to boiler pressures, the author of this paper says that there is practically no limit to the pressure that may be carried in a water-tube boiler. If the pressure becomes very excessive, the size of steam drum may ultimately have to be decreased and unusually powerful bending rolls built for shaping these small heavy drum plates. At the present time the tendency is to increase the volume of the steam and water spaces in these boilers by using larger drums than was the custom a few years ago. The present proportions could, without difficulty, be adopted for any working pressure up to 500 lbs. Therefore, at the present time the limit to the practicable high working pressure is determined by the engines. A Scotch boiler of moderate size for large steamship work, say 16 ft. diameter, built for a working pressure of 250 lbs., will require a shell 1⅞ ins. thick, and the rivets will be so large that only hydraulic machinery of very massive type can drive them. If a boiler of this size was intended for 300 lbs. working pressure, the shell would be about 2¼ ins. thick. This suggests the possibility of a great saving in weight in the water-tube type if it can be applied to the locomotive.

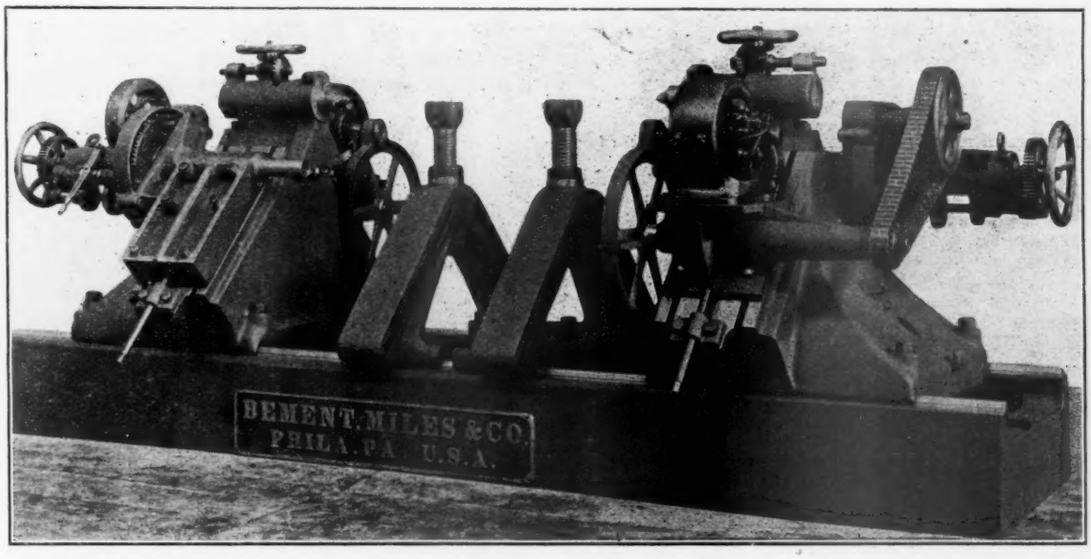
Put to the fresh college graduate the problem of the amount of distance to be left between the conductors of a high-tension transmission line. His answer will involve most likely the jumping distance of the voltage to be used, the length of span, the sag, and perhaps a liberal factor of safety. It is experience only that will show that his premises are wrong and that the equation to determine spacing of high-tension wires depends very little on the voltages to be carried and almost entirely on such things as the average length and ohmic resistance of cats, the spread of wing of owls and cranes and eagles, and the average length of scrap baling wire, together with the strength of the average small boy's throwing arm.—P. M. Lincoln, before the Canadian Electrical Association.

A NOVEL APPLICATION OF ELECTRIC DRIVING TO A QUARTERING MACHINE.

MEXICAN CENTRAL RAILWAY.

The engraving presented below illustrates an interesting new design of mounting electric motors for driving a quartering machine. Special features are incorporated which make the drive a model for simplicity, while it is also a radical departure from previous methods of driving tools of this kind.

This tool is an 85-in. quartering machine (interchangeable for quartering for right or left hand lead), recently built by the Bement, Miles & Co. works of the Niles-Bement-Pond Company, New York, for the Mexican Central Railway. It is to be installed at the new shops of this road, which will soon be completed at Aguas Calientes, an important division point 860 miles south of the El Paso, Tex., terminal and 585 miles north of Mexico City. In these new shops, which are notable for the use in their power plant of De Laval steam turbines driving Milwaukee direct-current generators, generous provision has been made for the use of electric driving. A three-wire system of distribution is delivering 250 volts for lighting circuits and 500 volts for power for operating the drives. Some interesting motor driving equipments are to be installed, of which this outfit is representative.



A NEW DESIGN OF ELECTRIC DRIVING FOR A QUARTERING MACHINE. DRIVEN BY A 3½-H.P. CONSTANT-SPEED CROCKER-WHEELER MOTOR UPON EACH HEAD.

The machine is driven individually at each head by 3½-h.p. constant-speed motors built by the Crocker-Wheeler Company, Ampere, N. J. The mountings for the drives are unusually interesting. Each motor rests upon a triangular-shaped block, arranged to slide on the inclined ways of the heads. This block also, by means of an extended sleeve, serves as a bearing support for the back shaft, which is driven directly from the motor pinion. Power is delivered from this intermediate shaft to the spindle drive at a considerable speed reduction through a Renold silent chain in either case. These chains are very easily tightened by merely lowering the motor blocks by means of the adjusting screws shown.

The tool is designed for quartering and boring crankpin holes in driving wheels up to 80 ins. in diameter on the tread. The usual centers are provided for centering the axles, as well as also the vertically adjustable V-blocks for supporting them, and to which the wheels are clamped. The boring spindles have 15 ins. traverse, and are provided with two changes of power feed, which are controlled by the clutch handle at the rear of the chain drive.

The most important feature of this design of driving is the provision for changing around for quartering with left instead of right hand lead. In either case the motor is located on the inclined ways on the opposite side of the head from the boring spindle which it drives. In changing the tool over, the positions of the motor and supporting block, and the boring spindle with its fixtures are merely reversed; this is accomplished by turning both the motor block and the spindle-bearing block upside down and bolting to the ways on the other side, each being so constructed as to fit on the inclined ways with either side up. In this way the relative locations and principal dimensions of the drive are not altered.

The effect of this design of drive is to make a much more compact arrangement than is usual where the motor is located elsewhere on the head. An idea of the neatness and simplicity effected by this arrangement may be gained from reference to the 84-in. motor-driven quartering machine in use at the Collinwood shops of the Lake Shore & Michigan Southern, which was illustrated on page 45 of our February issue. In this case the motor is mounted upon a bracket at the rear of the head, and the complication necessary to render the tool reversible is apparent.

YOUNG MAN'S CHANCES TO-DAY.

A young man of capacity, industry and integrity has a field for individual effort such as has never before existed in this country, says Edward Bok. And success is neither harder nor easier than it ever was. Success never yet came to the laggard, and it never will. His success depends upon himself. No times, no conditions, no combinations of capital can stop a young man who has a determination to honorably succeed, and who is willing to work according to the very utmost of his capacity and sinews of strength. The real trouble is that the average young man won't work. He has gotten the insane notion into his head that success comes by luck; that men are made by opportunities which either come to them or are thrust upon them. And he waits for luck or a chance to come along and find him. Instead of taking a sane view of conditions and seeing with a clear mind that as trade widens opportunities increase, he takes the mistaken view that the rich are getting richer and the poor poorer. These are the conditions of mind and life which are keeping thousands of young men down, and will keep them down. The times are all right. It is the young man who finds fault with them who is not.—*Graphite.*

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Nothing has appeared in connection with improvement in passenger car construction which can compare in importance with the new suburban equipment of the Illinois Central Railroad. Leaving entirely out of consideration the special side-door features and the means for rapid loading and unloading, the cars mark an introduction of new ideas which must, because of their merit, become important factors in the future. Here is a car which no collision is likely to demolish; one with a steel frame which requires no wood for purposes of adding strength, and one with a steel floor which is merely covered with a carpet of wood. It needs but little radical changing to make it an all steel car which will be light, strong and fireproof. It now weighs 61,400 lbs. in the body and 23,200 in the trucks and may be made much lighter without sacrifice of strength. It is not said that this is a perfect car. It is, however, a step in the direction which car construction for this service must take and is a hopeful indication of the possibility of building lighter cars which will be both stronger and safer than can be obtained with prevailing methods of construction.

Rapid progress is being made in the use of gas for furnace heating and power production in internal combustion engines. Mr. Sanderson directed attention to the possibilities of the internal combustion engine in his paper before the Master Mechanics' Association last June. As a matter of fact greater progress is being made than was indicated at that time. At the navy yard at Portsmouth, Va., gas fuel is used exclusively in blacksmith's work. Another good example of similar use is to be seen at the National Tube Works at Harrisburg, Pa., and still another at the works of the Winchester Repeating Arms Company, New Haven, Conn., where every forging, from a breech of a 5in. gun down to a cartridge ejector for a pistol is made by use of gas.

A New York concern has perfected gas plants, making gas from cheap fuel, which may be used in gas engines without gumming them up, and requiring very little purification. This process also supplies a gas with high heating value, which gives excellent results in welding operations. Also in England a well-known manufacturer of gas engines is now bringing out gas producers of small size and at small cost, with a view of operating them like boilers for small isolated plants

In these days most tools are bought for certain definite purposes. As an instance, take the case of small connecting rods, for which it will be decided that they are best dealt with in a taper turning lathe. Now, it is easy to calculate the exact length of time it should take to turn a given amount of surface. One can settle upon, say, 20 ft. per minute cutting speed with a feed of one-eighth roughing and three-sixteenths finishing. The total time required for the actual machining will be the maximum efficiency you have settled upon. When ordering a lathe for doing this work why should you not have a guaranteed time stated by the maker? Manufacturers of certain special tools do advertise to sell their machines on some such conditions, but the practice is very exceptional, and most tool makers absolutely ignore it. Attention paid to this question of time efficiency would do a great deal to improve the design and construction of many tools.

Readers say, "Your paper is full of good things in new shops, but tell us something about how to get good work out of the old tools most of us must use." Here is something for them: The writer found a Bement & Miles cylinder borer which has been run by the same man for the past 18 years, and he is still running it. It bores cylinders from 24 to 42 ins. in diameter. A new foreman was appointed, and the machine hand was encouraged to show what the old machine could do when driven by a new motor, but the speed of the boring bar has not been changed. By shrinking ½-in. rings on two of the feed cones, by using the former finishing-cut cone for roughing cuts, discarding the former slow-feed cones altogether, and by using three cutters in place of one, he now sets a cylinder, faces off

the ends, bores a roughing cut, a finishing cut, counterbores and faces off the flanges in three hours. For 17½ years the usual time for exactly the same work was 14 hours. The man now wants a 10-h.p. motor instead of a 5-h.p., and six cutters instead of three. He told the writer that he would gladly "cut the time in two" if he had the larger motor and a controller placed within reach, instead of against a column where he must take three steps to reach it. Now if "something happens" the cutters, and perhaps also the cylinder, are gone while he takes these steps. This old machine is rigid and fully equal to its present work. It makes a 5-h.p. motor heat up to a high degree, running as it is. The roughing cut of ⅜ in. and 5-16-in. feed goes through in 35 minutes. The cutting speed is 25 ft. per minute with the three cutters in a 20-in. cylinder. The writer timed the spindle roughly at four turns per minute.

SHOPS IN DESERT WASTES.

In the matter of selection of location for new railroad shops, difficulties have arisen which are as intricate as they are important, and point is given to these remarks by two cases in which it has been found impossible to effect a satisfactory shop organization in a reasonable time. The reason is that the shops have been built without sufficiently considering the labor market and fine new plants have been erected upon desert wastes as far as suitable facilities for housing the men are concerned. If it is desirable to locate shops at points remote from large cities something must be done to provide homes for the men or the best and steadiest men will not be had. This is not a matter of sentiment—it is to be expected as a matter of course. Railroads are sure to be disappointed if they expect good men to fill their shops and remain, steady and loyal, when the wages are less than those of manufacturing establishments and when they must necessarily live a long distance from their work. The question of wages is not now under discussion, but much might be said about that. The "shop train" does not solve the difficulty. There is no one thing to be done to attract and keep the best and steadiest men, but there are many factors in this problem, and they have not yet received the attention they deserve. Those who believe that shops can be located with reference to the convenience of the road itself without regard to the human problem involved, are likely, in time, to discover their mistakes. Much might be learned in this connection from the largest and most successful industrial establishments. These locate in or very near large cities or they in some way make it possible for employees to live comfortably within a reasonable distance of the works. They do not expect water to "flow up hill."

BIG LOCOMOTIVES AND THE COMPOUND.

BIG LOCOMOTIVES.

It seems to be sufficiently demonstrated that for business reasons we must have large and powerful locomotives. Whether they are popular or not, we must have them. It appears altogether improbable that there will be even a halt in the development of more powerful units, and there can be no backward movement, so firmly is the big engine entrenched. This is not a matter of individual opinion, but is because of a business development in transportation which has brought the heavy train and the enormous ocean liner. It is a part of the application of commercial principles to railroad transportation which began about ten years ago. Having the big engine, the problem is—how to make it satisfactory.

The failures of big engines are loudly proclaimed. They have failed in some ways. They have exposed many weaknesses, some internal in matters of design and others external, for which they are in no way responsible. Tractive power ranging from 40,000 to 57,000 lbs. involves great forces, necessitating good design and most careful construction. In such large units difficulties develop which have never been serious in small ones, and therefore entirely new problems have arisen. Those who have already done so much for the locomotive will not now hesitate or fail.

It seems necessary to turn toward that construction which disposes of the present enormous stresses by dividing them up among a larger number of parts which may be made smaller and lighter and arranged so as to best sustain the stresses.

One of the external weaknesses now brought to light is the inadequacy of even the best roundhouses, their equipment and efficiency for running repairs. The pooling system on many roads came simultaneously with heavier locomotives and also other changes whereby the locomotive was deprived of the interested individual attention of the men who ran it. This and the "prod" system of operation now give the roundhouse a new importance and a new responsibility. The largest engines on some roads cannot enter the roundhouses at all because of their size. They are sometimes too long for the turntables and require Y tracks for turning. They can be operated only on certain districts having specially heavy rails. In other places rails have been turned over and broken and bridges endangered. Side tracks have failed to contain the cars and draft gear to bear the strain due to the loads big engines can pull. Big engines have also exposed weaknesses in the offices of train dispatcher and superintendent. An old 6-in. spout does not fill a 7,000-gallon tender tank as quickly as one of 4,000 gallons. Shops without heavy cranes cannot lift big engines off their wheels and there are many of these archaic establishments about the country. In short, the big engine is about to show the need of several revolutions in railroad operation, and no wonder it is not popular. Nevertheless, large units of locomotive power constitute the force which is to draw the other factors of operation into line and this will mean more in terms of net earnings than any other influence now available.

Railroad owners who are wise will meet this problem immediately and generously. Motive power officers who are to do their part will have plans ready for a development toward heavier "power" in steps which will not swamp the other departments and will be prepared to recommend definite advances as often as warranted by their special conditions of service. Managers who are wise will see to it that their motive power departments are given the consideration required or they will soon find themselves in difficulties because of lack of motive power men of the right sort to deal with their part of the problem. This question needs immediate attention.

Those who are unwilling to properly maintain the big engines should expect them to fail, and they will surely continue to do so. Roads having many large engines cannot go backward. They are fortunate in that they must make them successful and thus become leaders in economical operation.

THE COMPOUND LOCOMOTIVE.

And what about the compound in this connection? Compounds are usually large engines. They are subject to all the difficulties faced by the big engine and more also. For example, roundhouses, roundhouse forces, shops and other facilities which are inadequate to keep up simple engines are less adequate to deal with compounds, for compounds need the "stitch in time" a little oftener than simple engines.

If railroads discard the compound it will be only a short time before they must return to it, and they will also find it necessary to adopt every other factor which will give increased capacity. Leaving out of account the fuel saving from the standpoint of economy, the limit to the physical endurance of the fireman will necessitate compounding. If automatic stokers succeed as oil burning has succeeded, compounding will be necessary in order to reduce the forcing of boilers and increase the life of fireboxes. The compound must be used because it will haul more tons than a simple engine and do the work easier with less forcing.

The compound does not need a champion. It is not the compound that is "in the balance," but the facilities for taking care of it and for securing the advantages which it is admitted cannot now be had by any other device.

A careful and extensive study of the operation of heavy locomotives under present conditions leads to the unqualified conclusion that the large locomotive must be successful and that it must be a compound.

HEAVIEST LOCOMOTIVE EVER BUILT.

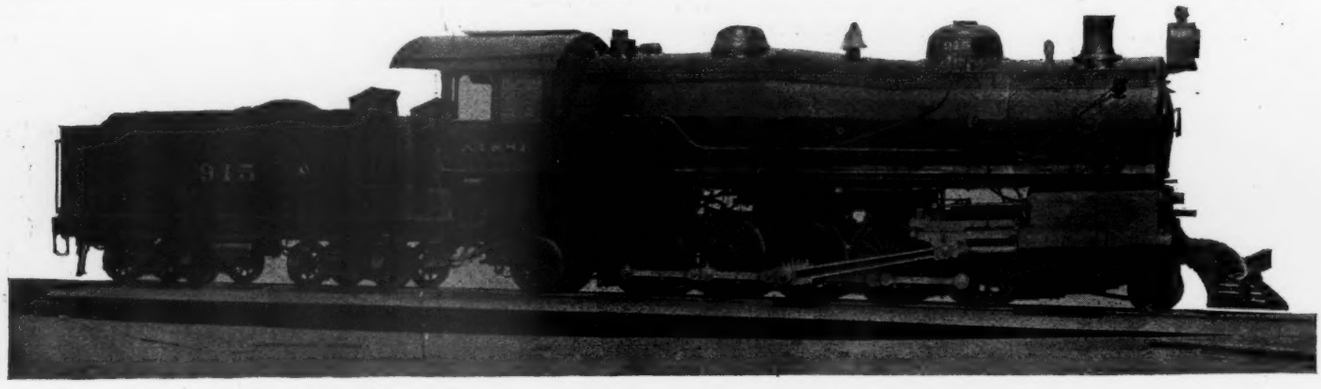
2—10—2 TYPE, TANDEM COMPOUND.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

The Baldwin Locomotive Works are delivering 70 new locomotives of what is called the Santa Fe type to the Atchison, Topeka & Santa Fe Railway. These are the heaviest locomotives ever built, their total weight being 20,000 lbs. more than that of the 2—10—0 type for this road illustrated on page 192 of our June number of 1902. These new locomotives merit a complete detailed description, which will be presented in the next issue of this journal. The following table includes the chief characteristics of this remarkable design:

SANTA FE TYPE FREIGHT LOCOMOTIVE.
ATCHISON, TOPEKA & SANTA FE RAILWAY.

Gauge	4 ft. 8½ ins.
Cylinder	19 ins. and 32 ins. x 32 ins.
Valve	Balanced piston



THE HEAVIEST LOCOMOTIVE EVER BUILT—ATCHISON, TOPEKA & SANTA FE RAILWAY.
SANTA FE TYPE (2-10-2) TANDEM COMPOUND. BALDWIN LOCOMOTIVE WORKS, BUILDERS.

Boiler	Type, wagon top; material, steel
Diameter	78¾ ins.
Thickness of sheets	⅞ in. and 15-16 in.
Working pressure	225 lbs.
Fuel	Soft coal
Staying	Radial
Firebox—Material	Steel
Length	108 ins.
Width	78 ins.
Depth	Front, 80¼ ins.; back, 78¼ ins.
Thickness of sheets:	
Sides, ⅝ in.; back, ⅝ in.; crown, ⅝ in.; tube, 9-16 in.	
Water space	Front, 4½ ins.; sides, 5 ins.; back, 4 ins.
Tubes—Material	Iron. Wire gauge, No. 11
Number	391
Diameter	2¼ ins.
Length	20 ft.
Heating surface—Firebox	210 sq. ft.
Tubes	4,586 sq. ft.
Total	4,796 sq. ft.
Grate area	58.5 sq. ft.
Driving wheels—Diameter outside	57 ins.
Diameter of center	50 ins.
Journals	Main, 11 x 12 ins.; others, 10 x 12 ins.
Engine truck wheels (front)—Diameter	29¼ ins.
Journals	6½ x 10½ ins.
Engine truck wheels (back)—Diameter	40 ins.
Journals	7½ x 12 ins.
Wheel base—Driving	19 ft. 9 ins.
Rigid	19 ft. 9 ins.
Total engine	35 ft. 11 ins.
Total engine and tender	66 ft.
Weight—On driving wheels	234,580 lbs.
On truck, front	23,420 lbs.
On truck, back	29,240 lbs.
Total engine	287,240 lbs.
Total engine and tender (about)	450,000 lbs.
Tank—Capacity	8,500 gals.
Tender—Wheels	Number, 8; diameter, 34¼ ins.
Journals	6½ x 10 ins.

MOTOR DRIVEN ICE MACHINES.

Refrigerating machines driven by electric motors appear to be very satisfactory. Mr. Fred L. Kimball makes the following statement in an article in *Engineering Magazine:* "The cost of refrigeration under this system is not prohibitive even when electricity is supplied from coal-burning stations. In a certain installation which was visited recently, it was found that a machine of 1-ton nominal capacity, operated by a 3-h.p. motor, was furnishing refrigeration for a storage room 25 ft. x 15½ ft. x 8 ft. and a delivery chest 20 ft. x 1 ft. 8 ins. x 6 ft., at an expense of $1 per day—the average temperature obtained being 42 degs. Of this $1, 56 cents was for electricity and 44 cents for water. The current was supplied by meter at 3 cents per kw.-hour, and the water at 12 cents per 1,000 gals." The whole plant cost $1,000, repairs for 18 months cost less than $5, and the saving over the cost of ice averaged $12 per week, ice costing $3 per ton. This may interest railroad officers who are paying high prices for ice.

THE TECHNOLEXICON OF THE SOCIETY OF GERMAN ENGINEERS.

In the beginning of 1901 the Society of German Engineers (Verein Deutscher Ingenieure) began the compilation of a universal technical dictionary in three languages—English, German and French. The undertaking has met with general approval and has received assistance from all quarters at home and abroad. Societies and individuals have responded generously to the invitation to collaborate and have proved their interest by sending collections of technical words.

Up to the present there are 343 societies (44 in English, 272 in German, and 27 in French speaking countries) co-operating in the work, either by the systematical collection of technical expressions of the specialities represented by them or in other ways, especially by the acquisition of collaborators and by placing technical publications in more than one language at the disposal of the "Verein," as catalogues of firms, inventories, price-lists of machines, handbooks, etc.

Through these societies the Technolexicon has found helpers in Great Britain, Germany, France, the United States, Austria, South Africa, India, Australia, Belgium, Canada, etc. Among the American societies who are lending assistance to this important work may be mentioned the American Society of Civil Engineers; the American Society of Mechanical Engineers; American Railway Engineering and Maintenance-of-Way Association; the American Chemical Society; the Western Society of Engineers; etc.

The contributions will not be called in before 1904, so that all who wish to help in the compilation of the Technolexicon have still time. Contributions in only one language are acceptable, though of course those in two or three languages are the most valuable, as also polyglot business-catalogues and other technical publications. The editor-in-chief will be pleased to give any information wanted. His address is: Technolexicon, Dr. Hubert Jansen, Berlin (NW. 7), Dorotheenstr. 49.

As to the reliability of the Parsons steam turbine, Mr. Griffiths, engineer to the Belfast Harbor Commission, stated before the Institution of Naval Architects (England) that he had operated pumps with them night and day for three years and they had never given the slightest trouble.

MACHINE TOOL PROGRESS.

FEEDS AND DRIVES.

X.

BY C. W. OBERT.

The variable-speed feeding mechanism that the Hendey Machine Company, Torrington, Conn., are applying to the latest models of their Hendey-Norton milling machines is similar in principle to the design which is so well known for its use upon the Hendey-Norton engine lathes. It is an adaptation of the cone of gears and shifting pinion principle which the Hendey Machine Company have developed as pioneers in the field of variable-speed feeding for machine tools.

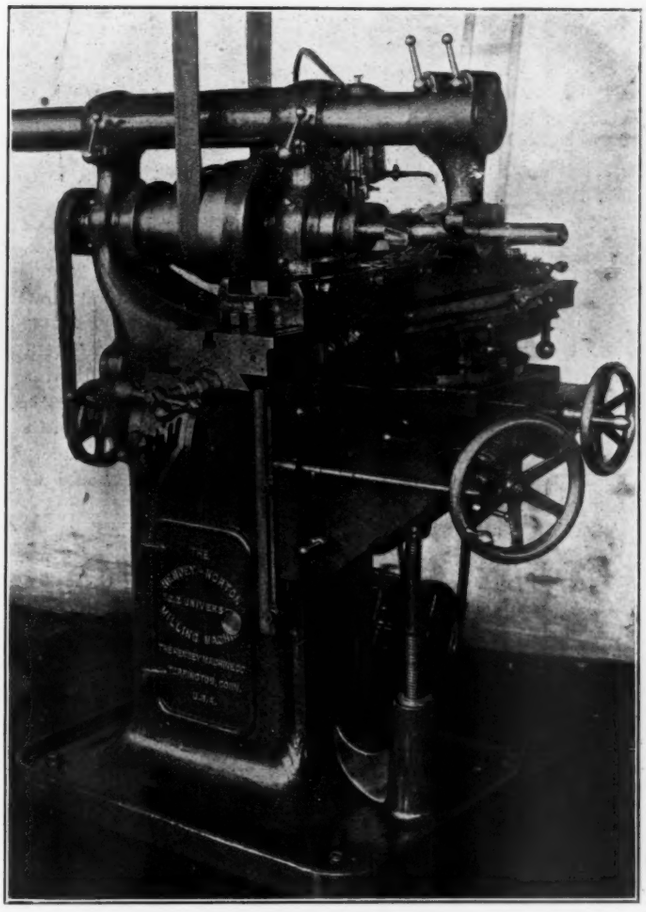


FIG. 49.—VIEW OF THE HENDEY-NORTON MILLING MACHINE, SHOWING CONVENIENT ARRANGEMENT OF THE SPEED-BOX IN THE FRAME AT THE LEFT.

The speed box is of renewed interest, in this application, particularly for the method of adaptation to milling machine conditions.

The device, as arranged for use in this case, is shown in detail in the drawing, Fig. 50, and its location upon the milling machine is indicated in the engraving, Fig. 49. The entire mechanism is located within the frame, and is thus quite out of the way and protected from dirt and chips. In this way the mechanism requires much less than would the belt cone and pulley arrangement.

The mechanism is driven by a belt connection to the spindle, the belt and pulleys appearing at the rear of the tool in Fig. 49. The lower pulley is keyed on the shaft which carries the shifting pinion, the latter being the driving member in this case as in the feed box used upon the Hendey-Norton lathes. The feeding motion is delivered to the table from the upper shaft which carries the cone of gears, the connection to the table being made through a telescoping shaft and universal joints, at the rear of the frame, in the usual manner.

The driving shaft for the mechanism is shown at D, Fig. 50, and the shifting pinion which it carries appears at O. This pinion, O, feathers with shaft D, and is controlled in its longitudinal movement by frame F, which embraces it by the forked projections pivoting on shaft D. The gear, P, is also carried in this frame in permanent mesh with pinion, O, gear P, being the one which is used for meshing with the gears of the cone. This is accomplished as in the device used upon their lathe, by lifting the handle, H, outside and locking it in one of the slots in the index plate X. Shaft S, carries the cone of gears and it is from this that the power is delivered to the table feeds.

In this way pinion O, which always revolves with driving shaft D, drives gear P, which, when brought up into mesh with any of the gears of the cone, drives the latter and with it, the delivery shaft S. Thus handle H is instrumental in not only starting and stopping the feeds, but also in making seven changes of feeding speed (six changes only on the No. 2 milling machine).

The small vertical slots in the index plate X, and the spring locking latch on handle H (as shown in Fig. 50), ensure proper meshing of the gears and also prevent interference of gear P, with the others of the cone on either side of the one driven.

Two extra changes of speed are also furnished by another gear arrangement next to the driving pulley, as shown in Fig. 49, which increases the total number of speeds available up to 21 (18 on the No. 2 machine). This attachment is similar in principle to the 7-speed mechanism, but is arranged for three different delivery speeds only. It is located outside of the frame near the driving pulley, but is protected by a gear case or cover. The arrangement of this mechanism is very commendable and its application will undoubtedly be as highly appreciated on the milling machines as it has been on the Hendey lathes.

The design of the feeding mechanisms for the Hendey-Norton milling machines is particularly heavy and rigid, the desire having been to render them capable of the heaviest duty for rapid production in milling processes. The result has been that some remarkable instances of heavy milling performances have been accomplished in many cases. For example, the photograph, from which the engraving, Fig. 49, was made, was taken while a remarkably heavy milling performance was being made, the conditions of which are as follows: The machine used was the No. 2 universal Hendey-Norton miller, with no special adjustments, and the stock being milled was a bar of 50-point carbon steel with 1⅞-inch face. In one instance, a one-eighth-inch cut was taken with the feed mechanism set for

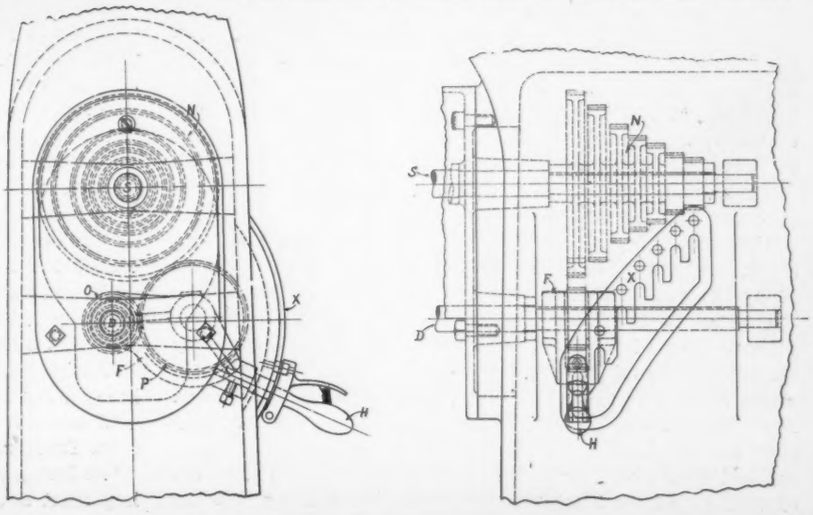


FIG. 50.—DETAILS OF THE VARIABLE-SPEED FEED MECHANISM APPLIED TO THE HENDEY-NORTON MILLING MACHINE.

a table feed of 3 1-3 inches per minute, and in another, a 1-10-inch cut was taken with a table feed of 4 inches per minute. In both cases the work was carried very easily and no trouble was met in any way. This heavy performance was made with no special preparations, a stock arbor and a stock cutter being used, and also the arbor support was not set as close to the cutter as would ordinarily have been done. This is another important proof of the advantage to be gained from the use of the heavy gear-drive feeding mechanism.

THE MACHINE SHOP PROBLEM.

The following paragraphs are selected from a paper read before the American Society of Mechanical Engineers by Mr. Charles Day:

Reviewing, briefly, past conditions in the majority of shops—and in fact many of to-day—we cannot fail to be impressed by the slipshod methods in use on all hands. Purchase of equipment was left almost invariably to a purchasing agent who was in no way conversant with the requirements of machines to be bought, price being his only means of comparison. The fact that such a condition of affairs was allowed to exist was sufficient proof that those in charge of the shop were scarcely more capable to judge of the earning power of the apparatus than he.

Some of the largest shops used a cheap grade of carbon steel for cutting tools, instead of the "air-hardening" variety which would permit of double the cutting speed, the reduced first cost being their reason for this policy. In such a plant five thousand dollars ($5,000) invested in tool steel might readily effect a saving on the labor bill of fifteen thousand dollars ($15,000) annually. Such an illustration exemplifies forcibly the absence of scientific thought and investigation existing but a few years since.

Probably nothing has increased the possibilities of the machine shop to a greater degree than the power crane, and although the designer of the building is always informed, in a general way, as to the crane service that will be required, this detail is not usually given nearly sufficient consideration. To properly cover the floor space with power cranes, jib cranes, etc., requires a most careful study of the location of various machines, which, in turn, necessitates a thorough understanding of the work in view.

The lighting of the machine shop or foundry to a marked extent influences the efficiency of the men, and the importance of this fact is generally appreciated at this time. It is practically impossible to obtain too much light, provided the direct rays of the sun do not fall on the work. As large establishments usually run night and day, a liberal amount of artificial light is also necessary if the different shifts are to turn out equal amounts of work. Shops that are illuminated in a general way by arc lamps (as well as incandescent lights for detail work) seldom complain of the inefficiency of the night shift.

The efficiency of machine shop equipment should be judged only from its ability to produce the desired result at a minimum cost, and this, in turn, is governed as much by the information at the disposal of the operators as the machines themselves. In the extreme case, such as a full automatic screw machine, we might suppose that the ability of the designer would assure the success of the tool; but even in this case innumerable details arise, such as the grinding and setting of cutters, the delivery of stock to and from the machine, etc., which may or may not be efficiently taken care of by the purchaser.

Turning to the other extreme—an engine lathe doing a general class of work—we find the workman confronted by innumerable problems, governing economical production, which he, and in many cases his superiors, fail to recognize. For example, the proper cutting speeds for different materials and different cuts; the relative advantage of a heavy cut and slow speed, or a light cut and fast speed; and the capabilities of the machine. These are but a few of the details. Such information can only be obtained from experimental work carried on along scientific lines, and as long as schemes of management take no cognizance of this data, the introduction of modern tool steels, the motor drive, etc., will necessarily be slow; consequently we cannot discuss the merits of various types of apparatus, unless conversant with the problems of organization and management. The absence of this knowledge leads many engineers to most erroneous conclusions.

The small attention given to the cutting tool in the vast majority of shops is astonishing when we realize how directly the time of machining is dependent on the character of the steel. We are all constantly hearing of phenomenal cutting speeds, etc., but it is the efficiency of the tools in the tool racks that is a gauge of their value. If these tools are not forged and ground to standard angles and reground by a man who realizes fully the care which must be exercised in this work, the chances are that the majority of them will be but scarcely better than the original steel.

If a cutting tool is to work at its maximum efficiency, the cutting speed should be maintained constant for a given depth of cut and a given feed, consequently some means should be provided for accelerating the spindle speed of a lathe when the tool is working from a larger to a smaller diameter, such as facing cylinder heads, etc. A lathe of this character may be truly termed a variable-speed machine. In the average shop, however, there is very little opportunity for work of this kind, the majority of lathe work consisting of longitudinal cuts. If the lathe operates on but one class of work, the proper spindle speeds and feeds can be obtained, which should not be changed as long as conditions remain unaltered. If, on the other hand, a great variety of work is handled by a lathe, the tool will constantly work on different diameters, variable speed being equally as important in this case as in the first considered, although a uniform increase, as the work proceeds, would not be required. Simple as this classification may seem, the electrical engineer repeatedly fails to see that a system of motor driving that would be applicable in one case utterly fails in another.

Practically all machine shops have some variable-speed tools, and, here again, it is the province of the engineer to determine the relative importance of the various factors. A manufacturer who advertises a variable-speed countershaft or motor for machine-tool driving which will give any speed, shows his ignorance of shop conditions where a refinement of this kind cannot be used to advantage. In fact, after visiting practically all the shops that have installed multiple-voltage equipment offering the possibilities of close speed regulation and ease of handling, we are convinced that the purchasers are not beginning to realize an adequate return on the investment. A better illustration could not be found of the interdependence of management and equipment.

TO YOUNG MEN.

"There is plenty of room at the top, but there is no elevator in the building.

"There are times when it's safest to be lonesome.

"Being popular takes up a heap of time.

"Putting off an easy thing makes it hard, and putting off a hard one makes it impossible.

"Have something to say; say it; stop talking.—Rules for a business conversation.

"The house is not interested in knowing how you like your boss, but in how your boss likes you.

"Remember that when you're in the right you can afford to keep your temper, and that when you're in the wrong you can't afford to lose it.

"Enthusiasm is the best shortening for any job; it makes heavy work light.

"Remember that to-day is your opportunity, to-morrow some other fellow's.

"In keeping track of others and their faults it is very, very important that you shouldn't lose sight of your own."

These bits are gleaned from "Letters from a Self-Made Merchant to His Son."

WOODWORKING MACHINERY.

IMPORTANT DEVELOPMENTS IN INDIVIDUAL DRIVING BY ELECTRIC MOTORS.

In the August issue of this journal was presented (pages 294 to 296) an article treating of modern methods of electrically driving wood-working tools. As may be inferred from the same, problems of greater magnitude and complexity are there met than are prevalent with iron-working-tool practice, and necessarily they demand special treatment. In this article is presented additional examples of motor-drive equipments for wood-working tools, in order to indicate to those meeting problems of this nature what may be termed prevalent practice.

The tools illustrated herewith are representative examples selected from a large installation which the Triumph Electric Company, Cincinnati, Ohio, recently fitted up for electric power transmission and motor driving. The motors are all Triumph motors of the inclosed type, which are particularly adaptable to this class of driving, in which dust and shavings are met in quantities. A notable feature of this interesting installation is the conspicuous absence of overhead belts. The result is a beautifully light and airy shop, which will be thoroughly appreciated by those who have to do with belt-drive shops.

The first engraving, Fig. 1, illustrates an interesting direct-coupled drive on a 9-in. four-head sticker. This is an instance where the comparatively high speed of the motor agrees favorably with the driven speed of the machine, permitting a direct coupling between the armature shaft and the machine's drive. The motor used for this drive is the standard 15-h.p. floor-type Triumph motor, operating at 900 rev. per min. This drive is unexcelled for economy of space and neatness.

In this engraving is also illustrated one of the ceiling motor drives, which are used in this installation for driving the groups of light machinery. The group-drive method of arranging the machinery was adopted for the lighter tools, a grindstone and a wood lathe only being driven from the one motor in this case.

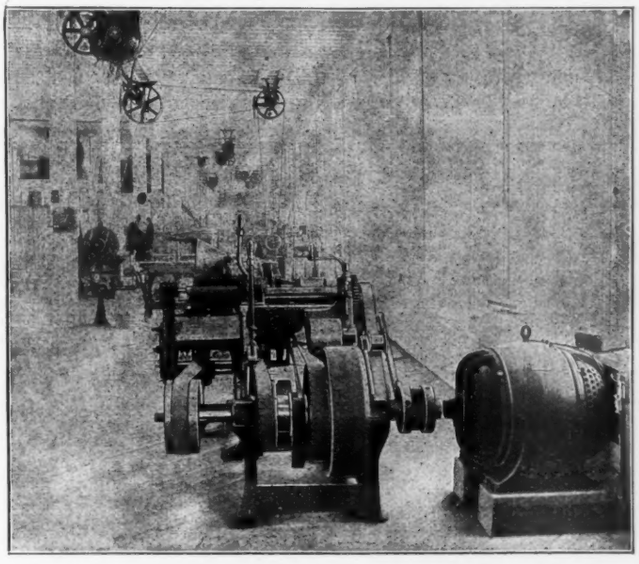


FIG. 1.—DIRECT-COUPLED DRIVE FOR A 9-INCH STICKER. DRIVEN BY A 15-H. P. MOTOR.

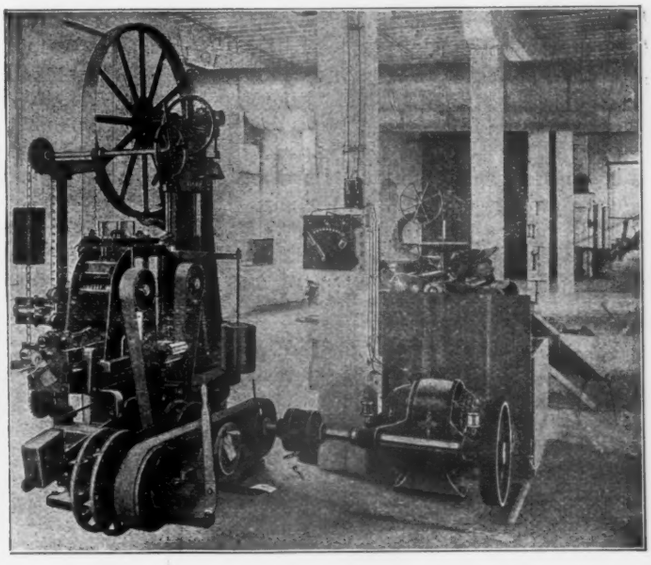


FIG. 2.—BAND RESAW, EQUIPPED WITH A DIRECT-COUPLED DRIVE FROM A 15-H. P. BACK-GEARED MOTOR.

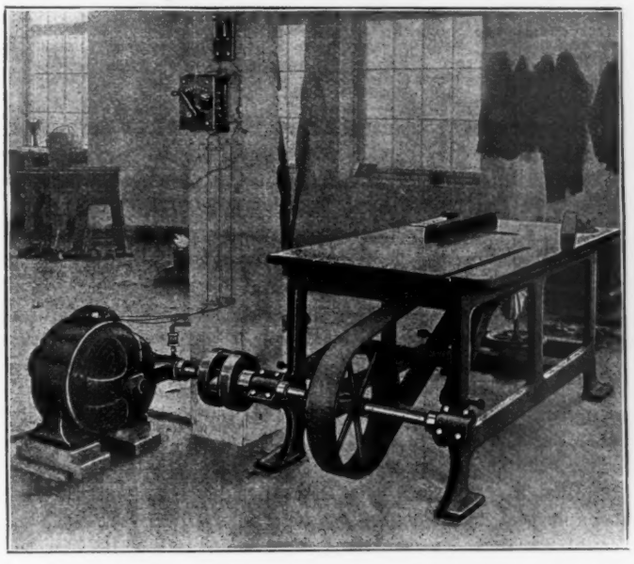


FIG. 3.—A 12-INCH RIP SAW WITH A DIRECT-COUPLED DRIVE FROM A 10-H. P. BACK-GEARED MOTOR.

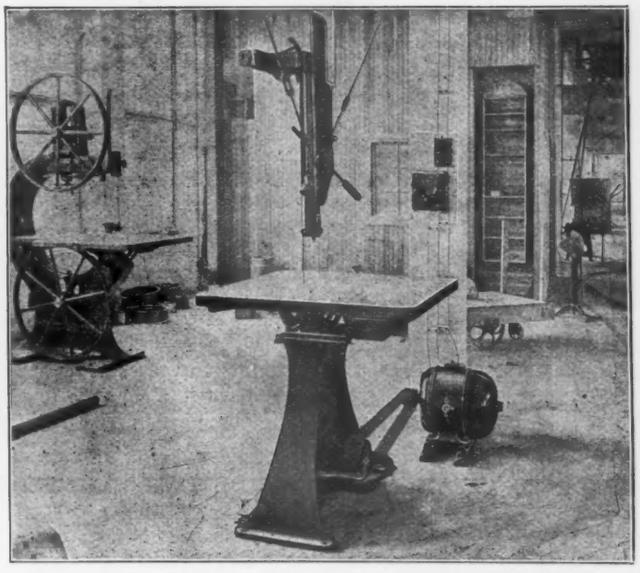


FIG. 4.—BELTED DRIVE FOR A JIG SAW FROM A 1-H. P. SLOW-SPEED MOTOR.

The next two engravings, Figs. 2 and 3, as well as the ceiling motor illustrated in Fig. 1, present examples of the use of the Triumph Electric Company's back-geared motor. Fig. 2 is a view of an inclosed floor-type, back-geared motor coupled direct to a band resaw, with power feed, built by the Frank Clement Company, of Rochester, N. Y. Fig. 3 illustrates a similar motor direct-coupled to a 12-in. rip saw. In the two latter cases the gear ratio chosen for the back gear on the motors

was such as to accommodate the resulting driving speed to that required by the machine. This is an excellent feature of the back-geared type of motor in avoiding belt driving.

The band resaw, Fig. 2, is driven by a 15-h.p. motor, which operates at 1,100 rev. per min., but delivers from the back-gear shaft at 350 rev. per min. The rip saw, Fig. 3, is driven by a 10-h.p. motor, operating at 1,000 rev. per min., but which is back-geared down to deliver at 400 rev. per min., the back-gear speeds agreeing in both cases with the speeds of driving of the tools..

In Fig. 4 there is shown a belted individual drive from a 1-h.p. slow-speed inclosed motor to a fret or jig saw, and in Fig. 5 a similar drive for a band saw, built by the Frank Clement Company. The former motor operates at 1,100 rev. per min., while the latter saw, Fig. 5, is driven by a 2-h.p. slow-speed motor running at 1,000 rev. per min.

Fig. 6 illustrates another back-geared motor drive direct-coupled to a band resaw, built by Fay & Egan, Cincinnati, Ohio. The motor in this case is a 7½-h.p. inclosed floor-type motor, which runs at 750 rev. per min., but is back-geared down to deliver at 350 rev. per min.

The motors used in this installation are the well-known inclosed slow-speed, multi-polar motors, with laminated poles, manufactured by the Triumph Electric Company, which were

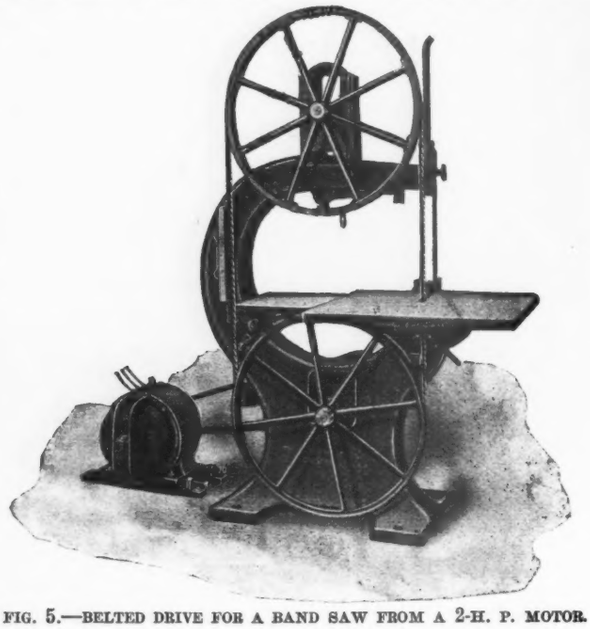


FIG. 5.—BELTED DRIVE FOR A BAND SAW FROM A 2-H. P. MOTOR.

illustrated and described on page 361 of our November, 1900, issue. They are all fitted with self-oiling bearings, carbon brushes and are designed for a minimum of sparking; the result aimed for in the general design of this motor is to render it absolutely reliable and as free as possible from repairs.

REDUCED CLEARANCE IN LOCOMOTIVE CYLINDERS.

The advantages of a reduction in clearance of steam engines are generally admitted. Many attempts have been made to adapt the principles of the Corliss valve motion for application to locomotives. These have all failed to attain practical success. They have usually consisted in the application of an entirely new valve motion with added complication. Mr. Ira C. Hubbell, in a paper read before the New York Railroad Club, last month discussed the effect of cylinder clearance upon the quantity of steam consumed in doing specific work and incidentally introduced the subject of the new Alfree valve gear, which is designed to effect the Corliss principle on a locomotive. This gear, however, makes use of the usual link motion and adds an attachment to the rocker arms with a connection to the crosshead. In this respect it differs radically from the attempts mentioned. It also includes an arrangement of a slide valve which permits of reducing clearance. An engine fitted with this valve gear has been running for two years and a number are now under construction for several railroads.

This valve gear stands for reduced clearance, for delayed exhaust opening and closure of the valves and for a combination of reduced clearance and such a degree of compression as to reach the initial pressure for the clearance used. It also stands for short, direct and smooth surface steam passages. In his paper Mr. Hubbell insisted that all clearance is waste and that the ideal condition with respect to economy would be one in which there is no clearance whatever. Upon this assumption he bases his predictions of steam consumption and believes that the economy will be greatest the nearer the clearance approaches to zero. The editors of this journal do not consider this opinion correct, but they believe that a mechanically satisfactory valve gear which will delay exhaust closure in such a way as to properly fill a correct volume of clearance is likely to be greatly beneficial to the locomotive, especially

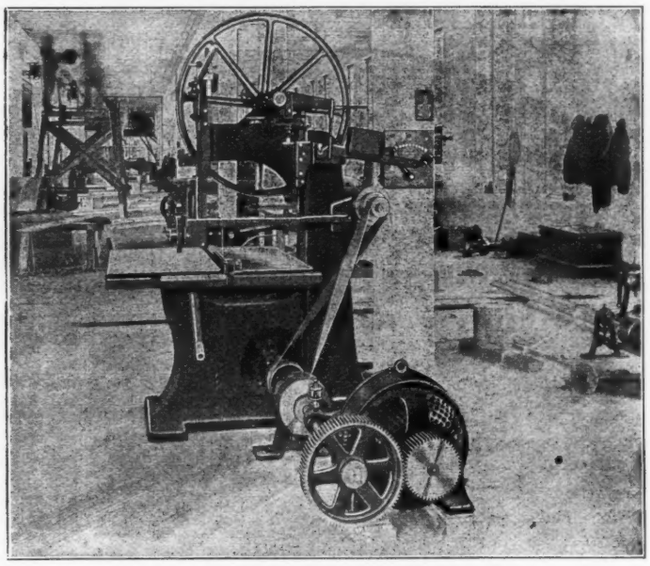


FIG. 6.—DIRECT-COUPLED DRIVE UPON A BAND RESAW,—7½-H. P. BACK-GEARED MOTOR.

if it permits of reducing clearance from 8 and 10 down to 2½ per cent.

An illustrated description of this valve gear will be presented in the near future in this journal.

CARE OF COMPOUND LOCOMOTIVES.

In discussing the care of compound locomotives before the Traveling Engineers' Association, among other things Mr. A. L. Beardsley said:

"Those of you who are familiar with some makes of compound locomotives have during the past winter ridden over the road when it was impossible for you to see the front end of the engine, and if it had an iron cab it was covered on the inside with frost and ice. You have had steam leaks around the front end of the engine so numerous that you could not detect where they came from and which one was the worst. This steam came from high and low pressure pistons, valve stems, cylinder heads, cylinder cocks, relief valves, cylinder cock pipes, etc., and did not have a tendency to make the engineer and fireman friendly to the compound. This engine on arrival at the terminal was put in a roundhouse that was too short and the doors could not be closed. The machinist was given a list of work on it that he could not do on account of these same steam leaks, the gas and smoke in the roundhouse and the fact that he could not keep his hands warm while at work. Some of the men who care for and handle these machines lost some of that interest in their work that is so valuable to railway companies. The repairs on these large compounds have been made difficult and laborious from the fact that the facilities for doing the work are in some cases limited and the roundhouses are inadequate."

NEW LOCOMOTIVE SHOPS AT TOPEKA.

ATCHISON, TOPEKA & SANTA FE RAILWAY.

II.

The previous article on this subject appeared on page 321 of the September number.

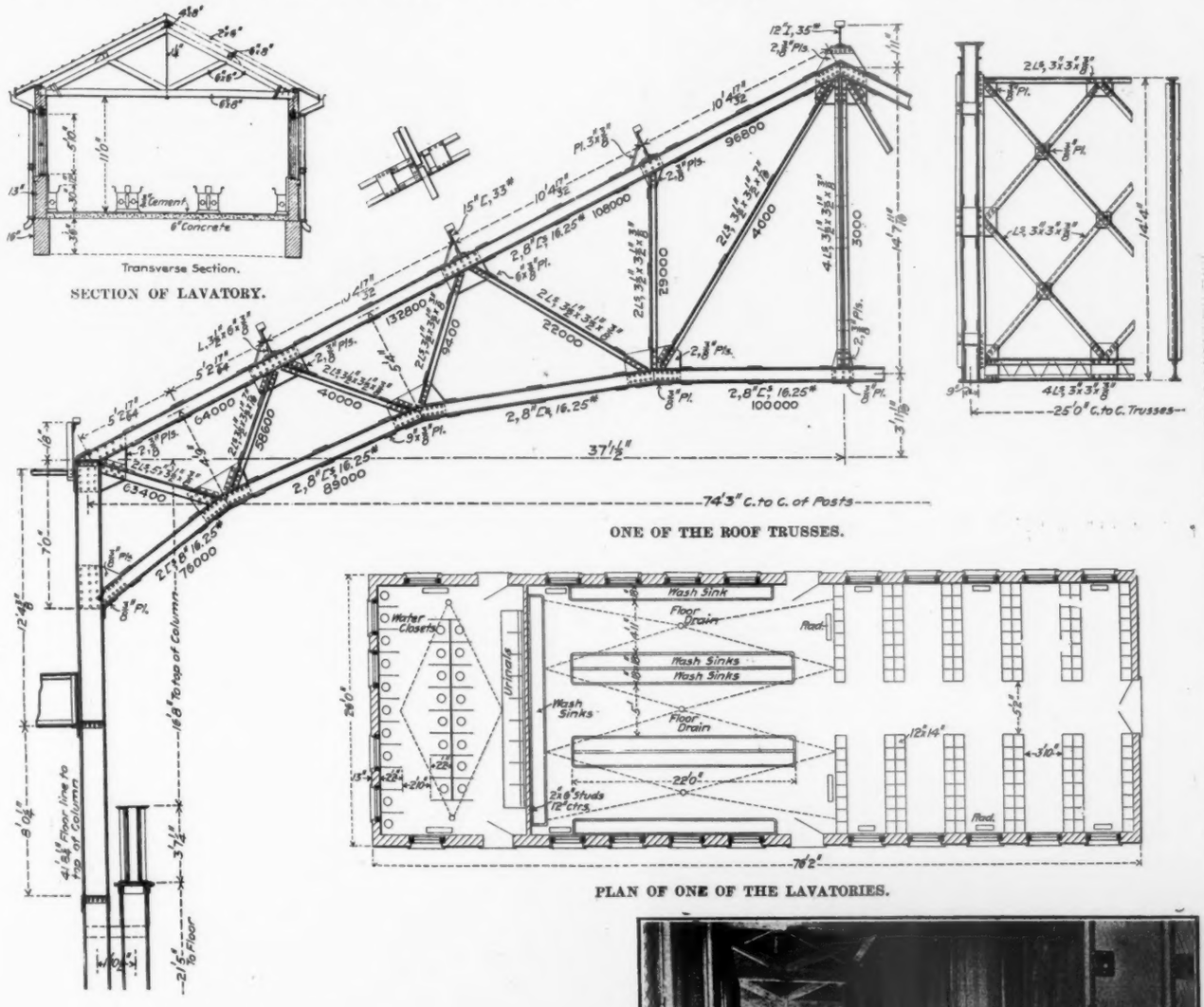
Before passing to the other features of this plant several illustrations should be presented. One of these shows the construction of the roof trusses in the locomotive shop. These are spaced at 25 ft. centers with a span of 74 ft. 3 ins. from center to center of posts. The steel work is heavy and is roofed with Ludowici tiling, as are also the saw-toothed portions over the side, or machinery, bays. The engraving of the truss shows the depth of the crane girders, the manner of supporting them and their height from the floor level.

Another engraving shows sections of the locomotive pits, which have already been referred to. These are built of concrete, as are all the foundations of the buildings, the machinery foundations and the ducts for the distributing system of hot air for heating and ventilating the building. One of the photographs shows a portion of a main duct and its connection to the fan room. This construction employed temporary wooden forms over which the concrete was built.

Steam, exhaust or live, is brought from the power-house to four Sturtevant fans, each 10 ft. in diameter by 5 ft. wide and of the three-quarter housed pattern. These are located outside of the main building in four fan-houses, shown on the ground plan. Each heater is capable of discharging 72,000 cu. ft. of air per minute at a speed of about 165 rev. per min. For the heating engines steam at 150 lbs. pressure is supplied. Each heater has 9,000 linear feet of 1-in. pipe, and discharges into the underground ducts. The following figures represent the heating problem:

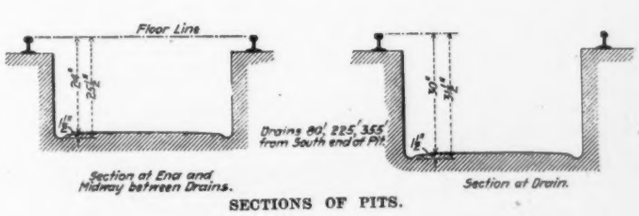
Cubic contents	5,400,000 cu. ft.
Glass surface	88,000 sq. ft.
Brick surface	49,000 sq. ft.
Tile surface	130,000 sq. ft.

SECTION OF LAVATORY.



ONE OF THE ROOF TRUSSES.

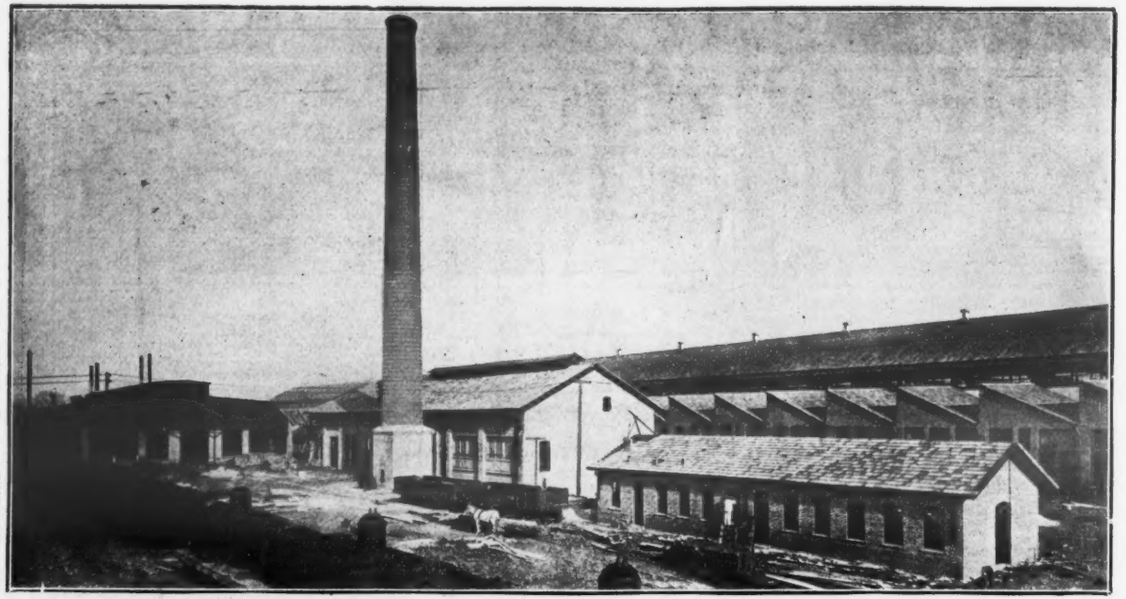
PLAN OF ONE OF THE LAVATORIES.



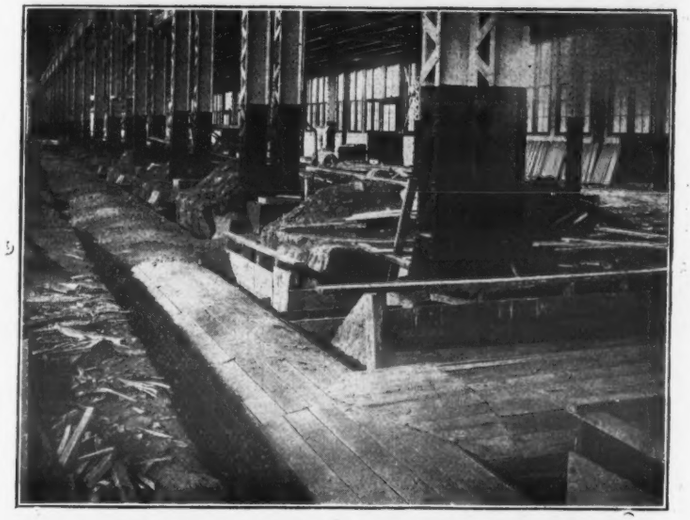
SECTIONS OF PITS.

ONE OF THE LAVATORIES.

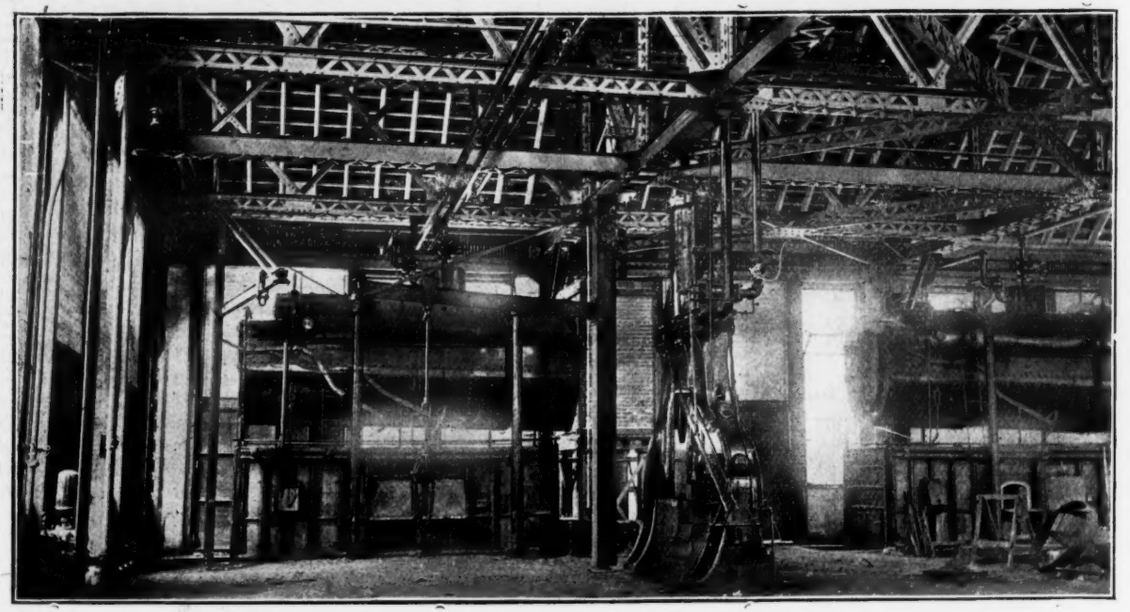
NEW LOCOMOTIVE SHOPS AT TOPEKA—ATCHISON, TOPEKA & SANTE FE RAILWAY.



BLACKSMITH SHOP—POWER HOUSE—WEST SIDE OF LOCOMOTIVE SHOP.



CONSTRUCTION VIEW OF A HEATING CONDUIT IN LOCOMOTIVE SHOP.



FURNACE, HAMMER AND ROOF FRAMING—BLACKSMITH SHOP.

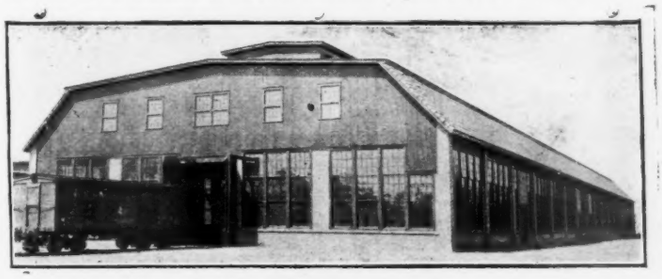
BALCONY FOR LIGHT MACHINERY IN LOCOMOTIVE SHOP.

NEW LOCOMOTIVE SHOPS AT TOPEKA—ATCHISON, TOPEKA & SANTE FE RAILWAY.

It was assumed that the air would change once every hour, and the plan was intended to heat 5,400,000 cu. ft. of air per hour from 10 below to 60 above zero, as a maximum capacity. In the large interior view of the shop one of the hot-air outlets is shown against one of the main columns at the left of the engraving at the foot of page 320. These outlets are of galvanized iron, and have swinging dampers. At present the heaters are arranged to take air from the building, but by constructing partitions across the fan-houses outside air may be taken to the heaters.

An excellent idea of the good natural lighting obtained with the saw-tooth form of roof construction is indicated by the small engraving of a portion of the balcony of the shop which is occupied by the tin shop, bolt, brass and other light machinery. The light is diffused and there are no dark corners. In entering this building this is one of its most striking features.

The blacksmith shop is 400 by 100 ft. The engravings show its exterior appearance and also the character of the steel roof-trusses, which are necessarily heavy, and span the entire shop, 100 ft. This building has brick walls at the sides and at the ends up to the window tops. The remainder of the ends are of galvanized iron. Ventilation is had through a monitor extending the full length of the roof, and there is no other provision for taking away the smoke from the forges. This shop has three 90-h.p. steam boilers over furnaces, and a fourth will soon be installed. These furnish steam for the steam hammers, which will be enumerated in another article. Because of the heavy roof construction the floor space of this building is entirely free from posts and is all available as working on machinery space.



BLACKSMITH SHOP.

Two 76 by 26 ft. lavatories are provided for the locomotive shops, located as shown in the plan on page 320, each containing in one end 26 closets and 9 urinals, in a room separated from the rest of the building by a brick wall. The rest of the space is about evenly divided between the wash sinks and lockers. Wood is used for the lockers, except the doors, which are of expanded metal. The lockers are in two tiers, each locker having a floor space of 12 by 14 ins. The arrangement as to spacing is shown in the plan view. One of these buildings is seen at the right of the engraving showing the blacksmith shop and power-house. They are of brick, with wooden trusses and Lodowici tile roofs.

An idea of the enormous traffic of the street railways in New York City was recently presented by Mr. H. H. Vreeland before the New York Railroad Club in the following remarks: "If you will take the Interstate Commerce Commission's report on the steam railroads of the United States and Canada of last year, with all their tremendous local service and their expenditures of hundreds of millions of dollars for terminal facilities to handle it, and then stop to consider that all of those railroads combined—225,000 miles in the United States plus the Canada lines—did not move as many passengers during the last fiscal year as were moved on the Island of Manhattan and in the Bronx, you will get some idea of the comparison of conditions. In Greater New York last year—and I am talking only of cash fares, not transfers—nearly twice as many people were moved as were moved by the total steam railroad mileage of the United States and Canada—more than one thousand million—of which number over 700,000,000 were moved in the Boroughs of Manhattan and the Bronx."

THE TRAVELING ENGINEERS' ASSOCIATION.

Several good papers were presented at the convention held last month in Chicago. The committee reports were concise and to the point. They give evidence of efforts to conscientiously reflect the opinions of members on all of the subjects treated.

Opinions with reference to the brick arch in locomotive fireboxes indicate the value of arches in soft coal locomotives as a source of economy. Arches are also beneficial in reducing black smoke. Where water is good there is no serious difficulty in maintaining arches, but where it is bad and much boiler work is required at terminals the advantages are offset by the expense and delays due to their presence in the fireboxes. The committee concludes that "taken from a standpoint of economy in dollars and cents, on shallow and wide firebox engines, the arch is not a benefit, except where work can be done properly and conditions will warrant its use." This report states that several roads are conducting experiments to determine whether the balance is in favor of or against brick arches.

Care and methods of handling compound locomotives was the subject of an admirable report, the essence of which is that railroad officers should "Give the compound a fair trial." The paper deals with the subject from a standpoint of economy and maintenance and presents simple suggestions which if carried out will render compounds satisfactory. The author presents a serious indictment of the too common neglect to provide suitable roundhouse facilities for caring for large engines. The entire paper should be read by every motive power officer, whether he has compounds or not.

The combined straight air and automatic engine and tender brake was supported by a strong paper by Mr. F. P. Roesch, who wound up by saying: "I feel that we are fully justified in giving it our unqualified approval and recommending its adoption on all freight and switch engines." A close personal study of the causes of break-in-twos where long trains are handled resulted in showing that 78 per cent. were due to releasing at slow speed. The present very heavy locomotives require retention of the brakes at the head end in order to guard against full release at the head end before the rear-end brakes are off. The surge resulting from releasing the forward end brakes is what causes the trouble.

Methods of lubricating piston rods were discussed by a committee. In the report results of experiments to determine the temperature of rods improperly lubricated were given, showing temperatures as high as 320 degs. The committee recommended the use of engine oil flashing at from 350 to 380 degs. It should be used in swab holders, with a wick feed from a cup, the delivery being from 5 to 6 drops per minute when using steam and 8 to 10 when drifting.

The committee on "The Traveling Engineer's Front End Arrangement" did not report anything positive or original; furthermore, the researches by Prof. Goss for this journal were ignored.

Mr. C. B. Conger's paper on water gauge glasses showed that these attachments are necessary. On wide firebox locomotives where there is but little room in the cab the men are afraid of them, but the fact remains that, especially in waters which are liable to foam, they give a safer indication of the water level than gauge cocks. Mr. Conger recommends the renewal of the glasses every thirty days on locomotives carrying over 180 lbs. of steam. He also recommends protective cages and speaks favorably of the "Reflex" glass.

A new circular has been issued by the Chicago Pneumatic Tool Company, which is devoted to a complete line of pneumatic tools for stone cutting and drilling. One of the special features is the Chicago Plug Drill, a new device just placed on the market. This is a hammer weighing but 18 lbs., and with it 60 plug holes ⅝ x 3 ins. were drilled in 60 minutes, 20 holes having been drilled with one sharpening of the drill. The circular also illustrates other stonecutters' hammers.

MOTOR-DRIVEN MACHINE TOOLS.

RECENT PRACTICE IN THE APPLICATION OF ELECTRIC DRIVING TO DRILLING MACHINERY.

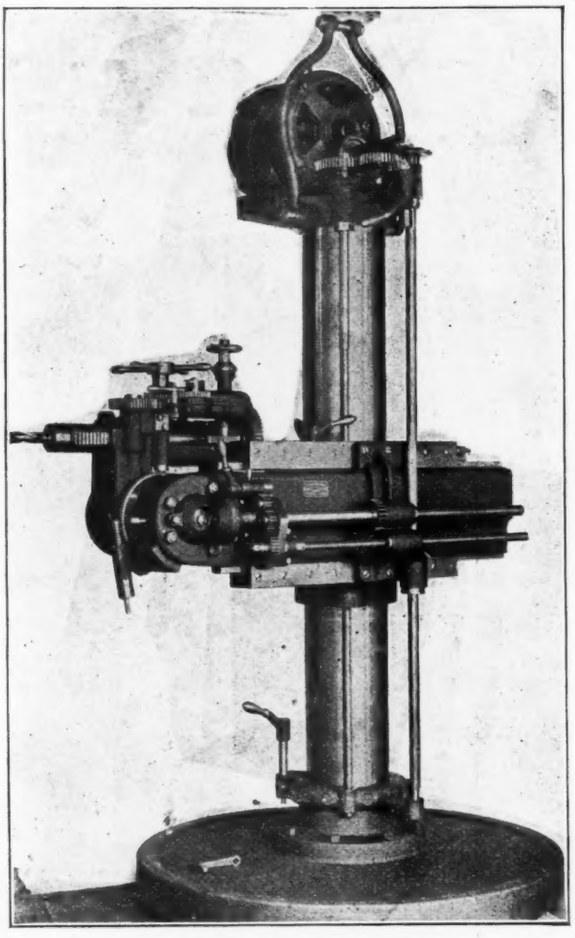
In continuation of the interesting examples of motor driving applications to drilling machines, which were presented on pages 340-342 of the September issue, we are pleased to be able to herewith illustrate some very interesting motor arrangements for driving radial and special drills, and also two interesting methods of mounting constant-speed motor-drives for using in connection with cone pulleys for speed changes. The latter cases are of interest to those who have to meet the problems of applying motors to old tools and cannot make use of the mechanical or electrical methods of obtaining variable speeds for the drive—a condition that is very frequently met in ordinary shop conditions. The following two examples of motor applications to special types of drilling machines are also of particular interest.

The first example is a special portable radial drill that well illustrates the advantages of the individual motor drive in the case of portable machine tools. This tool is a 5 ft. portable universal radial drill, which was recently built by Roos & Mill, Cincinnati, Ohio, for use in the shops of the Bullock Electric & Mfg. Co. It was designed especially for drilling and counterboring horizontal and vertical holes in electric motor yokes of from 6 to 15 feet inside diameter.

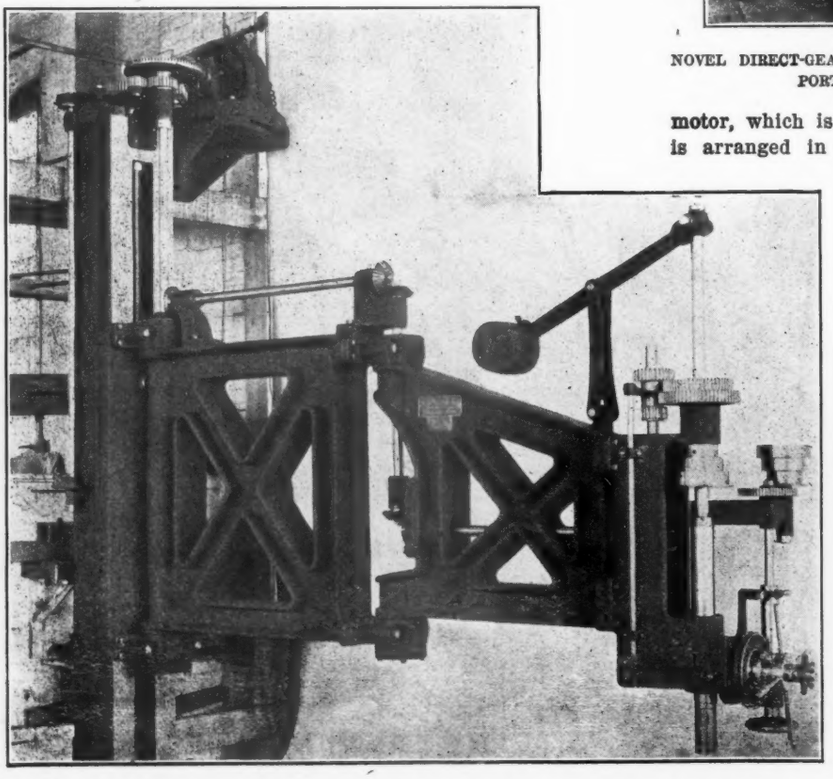
To perform the work, the machine is lifted by a crane and placed exactly in the center of the motor yoke and rigidly clamped at the base to the T-slotted floor plate, to which the yoke is also bolted fast. The center line of the spindle in its horizontal position runs exactly through the center of the column and all horizontal holes drilled in concentric surfaces will therefore be drilled in line with the center.

The spindle has a positive feed with four changes, has a quick return arrangement and is back-geared direct from the spindle-driving gear. The back-gear can be thrown in and out when the machine is running.

The column is provided at the top, in connection with the motor supporting bracket with a yoke by means of which the drill is suspended on the hook of the traveling crane. The motor, which is one of the standard type-N Bullock motors, is arranged in a horizontal position upon the supporting bracket, from which it drives the spindle mechanism through reduction gearing.



NOVEL DIRECT-GEARED DRIVE (BULLOCK MOTOR) UPON A SPECIAL PORTABLE RADIAL DRILL.—ROOS & MILL.



COMPACT GEARED DRIVE UPON A SPECIAL WALL REAMER AND DRILL. BAUSH MACHINE TOOL COMPANY.

The engraving at the left illustrates an interesting motor drive upon an 8-ft. wall reamer and drill, built by the Baush Machine Tool Company, Springfield, Mass., which is particularly adapted to bridge and boiler shop work. The convenience of an individual drive, applied as in this instance, cannot be better expressed than by reference to the illustration.

The arm of this drill is made in two gates, each 4 ft. long, the extreme distance to which the spindle will drill being 238 ins. The saddle has a vertical adjustment of 54 ins. and the spindle has a traverse in the saddle of 20 ins.

The motor, which is a 2-h.p. constant-speed direct-current Westinghouse motor operating at 1,200 revolutions per minute, is, as is clearly shown in the engraving, mounted upon a small bracket at the top of the upright from which it drives the spindle through a bevel reduction gearing, and also operates the elevating mechanism for the entire arm. The commendable features of this arrangement speak for themselves.

One of the tools illustrated below is the new improved 5-ft. radial drill, with mechanical variable-speed drive, built by the

American Tool Works Co., Cincinnati, O. It is equipped with a constant-speed motor drive, but a range of four different speeds is furnished by the speed box, beneath the motor. This device is operated by friction clutches by means of the handles shown in front of the box, which are arranged so that no conflicting clutches can be thrown in gear at the same time.

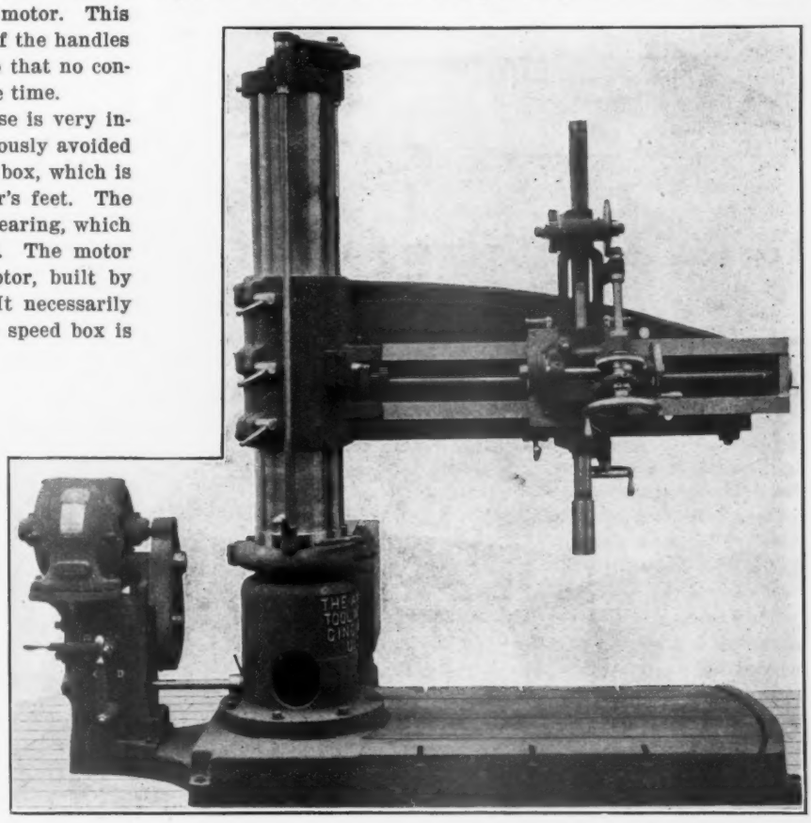
The arrangement of the motor drive in this case is very interesting. A special supporting bracket is ingeniously avoided by mounting the motor upon the top of the speed box, which is provided with projecting lugs to carry the motor's feet. The motor drives the upper shaft of the speed box by gearing, which gears are neatly protected by a cast-iron guard. The motor used in this case is a three-phase induction motor, built by the General Electric Co., Schenectady, N. Y. It necessarily operates at constant-speed so that the use of the speed box is in this case particularly necessary.

The arrangement of this speed box on the "American" radial is such, however, that the motor can be set down alongside of it, or on the floor, and drive by means of a chain or gearing. This method of driving through a speed box has, indeed, many important advantages.

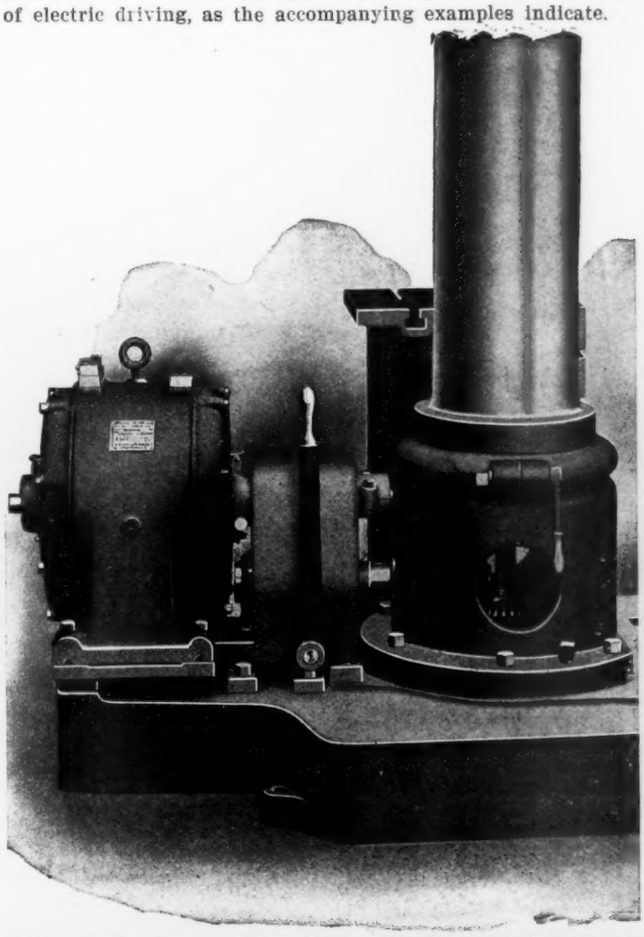
In addition to the large number of special features which this tool has incorporated in its design, may be mentioned the drill speed index plate, located on the motor, which indicates the proper arrangements of speed box levers for all sizes of drills, and in cast iron or steel, with the spindle back-gear in and out.

The accompanying engravings on this page illustrate three important examples from the adopted methods of motor applications which the Bickford Drill and Tool Company, Cincinnati, Ohio, are using for electric drives upon their radial drills. This company has had a great deal of experience with, and has given particular attention to, the matter of electric driving, as the accompanying examples indicate.

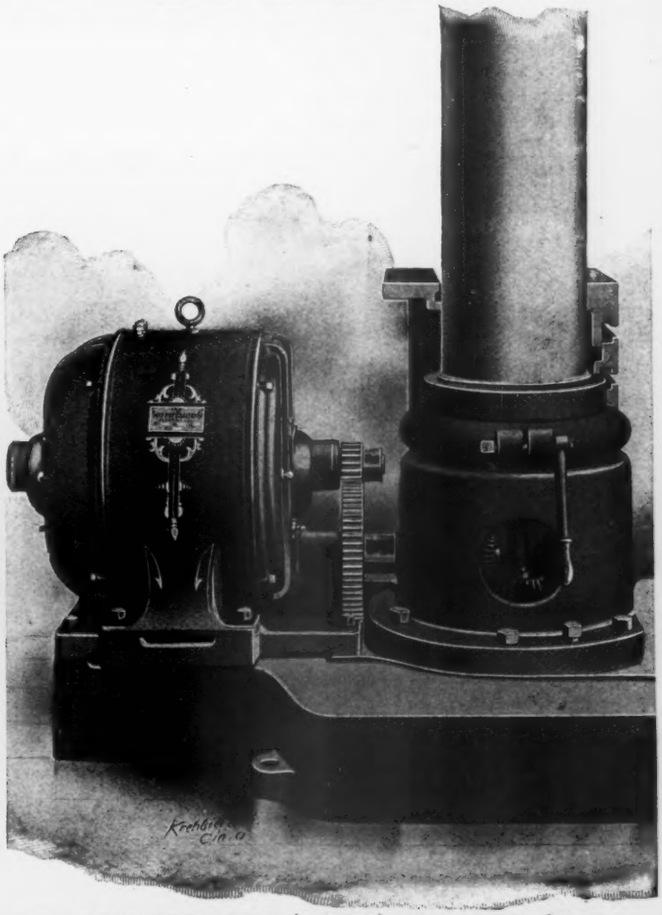
The first example, which is shown on this page as their style A drive, is an interesting arrangement of a constant-



DIRECT-GEARED CONSTANT-SPEED DRIVE UPON A 5-FT. RADIAL DRILL.—AMERICAN TOOL WORKS COMPANY.



GEARED CONSTANT-SPEED DRIVE (STYLE A) UPON THE NO. 1 RADIAL DRILL.—WESTINGHOUSE INDUCTION MOTOR.



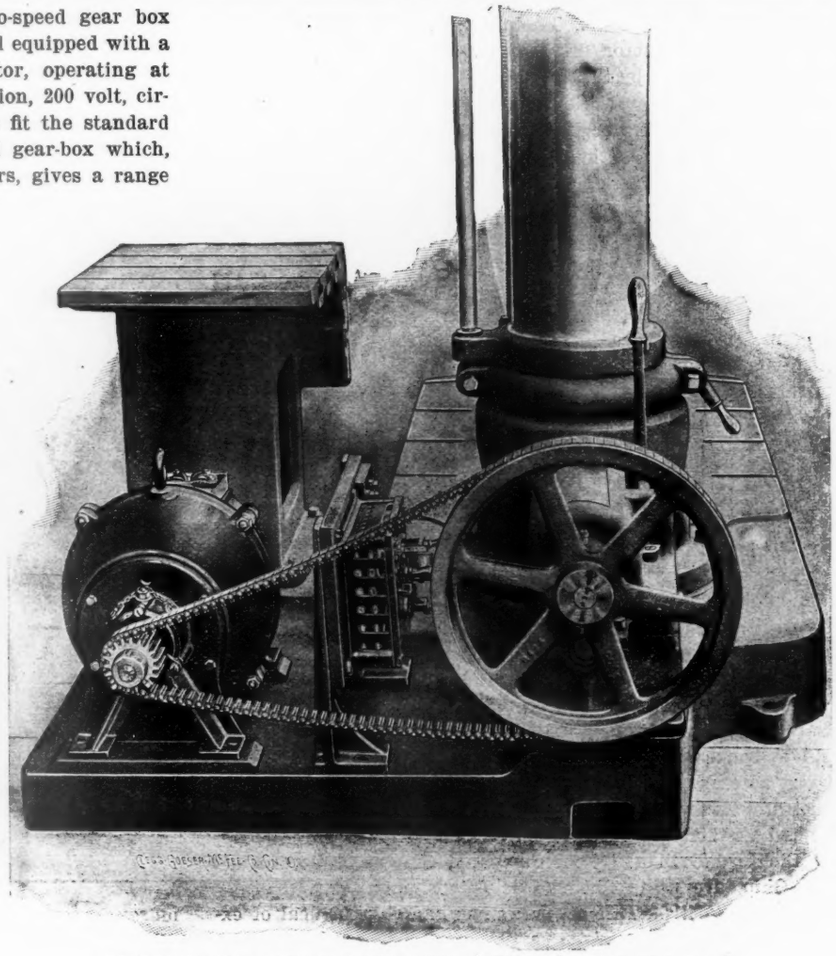
GEARED VARIABLE-SPEED DRIVE (STYLE E) UPON THE NO. 1 RADIAL DRILL.—TRIUMPH ELECTRIC COMPANY'S MOTOR WITH FIELD CONTROL.

BICKFORD DRILL & TOOL COMPANY.

speed motor used in connection with a two-speed gear box on the drill. This tool is the No. 1 radial drill equipped with a 3-h.p., Type C., Westinghouse induction motor, operating at 710 rev. per min., on a 2-phase, 3,000-alternation, 200 volt, circuit. The motor sets on a bracket made to fit the standard drill base and operates through a two-speed gear-box which, in conjunction with the four-speed back gears, gives a range of eight speeds, varying in geometrical progression from 46 to 176 rev. per min.

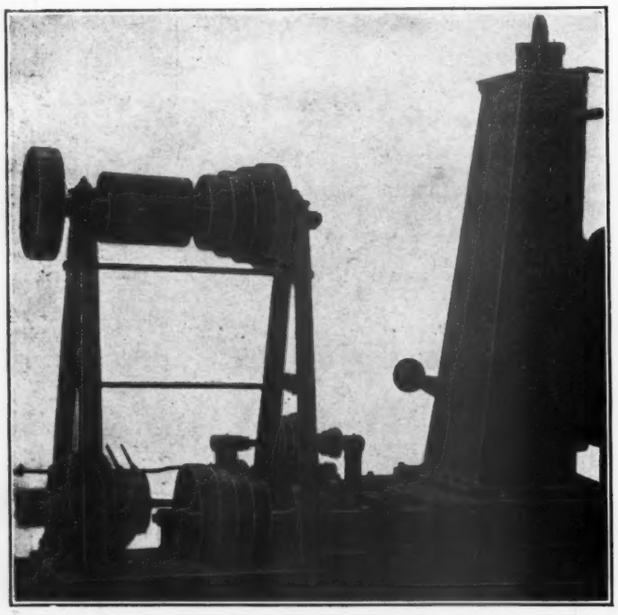
The above drive is not, however, to be generally recommended, as it is limited in speed range to only eight speeds; for use where a constant speed alternating-current motor must be used, it offers many advantages—this is a condition that is often met and is in this case well provided for.

The drive illustrated on this page, which is termed their style D drive, is more generally applicable, as it is arranged for direct current. This tool is also the No. 1 Bickford radial, and is equipped with a 3-h.p. Lundell constant-speed direct-current motor, mounted on an extension of the base. The drive is through a silent chain to the sprocket on the speed box, which in this case is the well-known 4-speed main driving mechanism which is used on the Bickford drills—this device was fully described on pages 178 and 179 of our May, 1903, issue. By means of this mechanism and the 4-speed back gear on the rear of the arm, 16 speeds are available at the spindle. As may be noted from the engraving, in this drive the motor starting box is located on the tool between the motor and speed box, making the tool and its drive entirely self-contained and capable of portable use in a shop.



SILENT CHAIN CONSTANT-SPEED DRIVE (STYLE D) UPON THE NO. 1 RADIAL DRILL.—BICKFORD DRILL & TOOL CO.

On page 381 is illustrated the style E drive of the Bickford Drill & Tool Co. This is stated to be their cheapest and best method of variable-speed driving, as the motor speeds are varied by field control, which is the more efficient method. In this drive the main-drive speed box is left off, as it is unnecessary.



AN INTERESTING ARRANGEMENT OF CONE-PULLEY COUNTERSHAFT FOR USE WITH A CONSTANT-SPEED MOTOR.—DESIGNED BY BEAMAN & SMITH.

This tool is also the No. 1 radial drill, equipped with a 3-h. p. variable-speed motor, built by the Triumph Electric Co., Cincinnati, O. It is mounted on an extension of the base, and the power is transmitted to the gear box by means of two spur gears and a raw-hide pinion which, after proper adjustment of the number of teeth in the pinion to suit the speed of the motor with which it is to be used, will furnish a correct range and gradation of speeds for all sizes of drills given on the standard Bickford speed-plates.

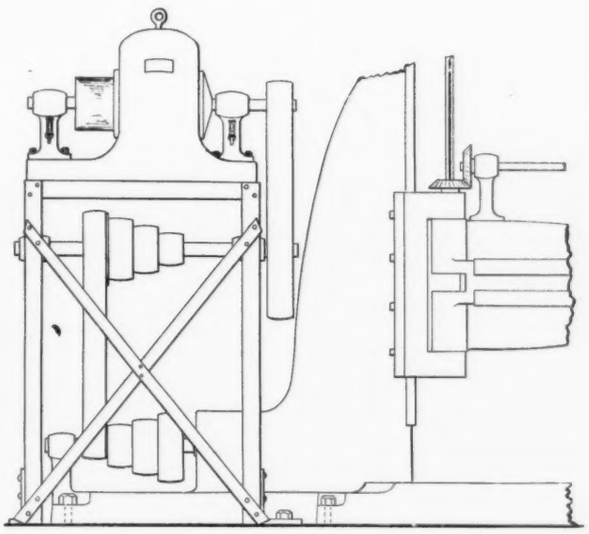
The two following engravings illustrate methods of mounting cone pulleys for use in connection with constant-speed individual drives, which have been used with marked success under conditions where any other arrangement would have been impossible.

The former is a view of a special A frame support that was designed by Beaman & Smith, Providence, R. I., for use upon one of their large horizontial-spindle drilling and boring machines. The conditions were such that it was necessary to mount the cone pulleys on the tool at the rear of the spindle column, and this arrangement provided for mounting them vertically without bringing the cone centers too close.

The A frames are of cast-iron, well braced, at the top of which is mounted the countershaft, which is driven by belt direct from the motor and carries the driving cone. The cone upon the tool's drive is directly beneath the countershaft cone. There is also a wide face pulley upon the countershaft from which is driven, through a belt shifter arrangement, the mechanism at the rear for raising and lowering the spindle saddle upon the column. The motor used in this drive is a 5-h.p., C & C. constant-speed, 220-volt, direct-current motor.

The remaining engraving shows a sketch of a motor mount that is in use at the Baldwin Locomotive Works, upon an individual drive that has been applied to a Niles radial drill. A large number of tools have there been equipped for electric driving, this example being one of the neatest arrangements to be found for constant-speed driving.

As may be seen from the sketch the stand is built up of angle-iron framing and is well braced. It rests on the floor independent of the drill and supports the motor, a Westinghouse constant-speed direct-current machine, upon the top. The motor drives the countershaft which is immediately below



MOTOR AND COUNTERSHAFT SUPPORT USED ON A CONSTANT-SPEED DRIVE FOR A RADIAL DRILL AT THE BALDWIN LOCOMOTIVE WORKS.

it, from which the drive of the tool is derived, as shown. This arrangement is very satisfactory, in spite of the closeness of pulley centers, and gives plenty of head room for cranes and take up almost no extra floor space.

ATTITUDE OF PRODUCERS TOWARD SPECIFICATIONS.

Dr. C. B. Dudley, of the Pennsylvania Railroad, presented a valuable paper upon "The Making of Specifications" before the American Society for Testing Materials, from which the following paragraph is quoted:

"We are well aware that many producers object to specifications on the ground that they are annoying and harassing, and really serve no good purpose. On the other hand, we are able to say that some manufacturers have asked that specifications be prepared, and one large producer indeed told us in conversation that the more difficult the specification the better they liked it, on the ground that it limited the competition which they would have in producing the product. There is a point here which is perhaps worth a few words. Let us suppose that an honest manufacturer is making a good product. He understands his business and has good facilities and is turning out an excellent article. When he comes to sales he is called upon to meet in competition, let us assume, those who are not equally well equipped, and who in order to secure a market must offer lower prices. In order to recoup for this diminution in price he, of course, must make an inferior product. So long, therefore, as the consumer buys on price alone, and without any specification or examination of shipments, the honest, competent manufacturer is at a disadvantage. On the other hand, if there is a good, workable specification in force and each shipment is examined, the unfair competition of the inferior manufacturer is entirely eliminated. We have many times stated in conversation with manufacturers that in our judgment those who are doing a legitimate, straightforward, honest business should be the strongest friends that specifications have, and it is gratifying to be able to state that many manufacturers of commercial products look at the matter in this light."

COMMUNICATIONS.

A SUGGESTION WITH REFERENCE TO THE "AMERICAN ENGINEER" TESTS.

To the Editor:

As the result of a careful study of Professor Goss' report upon the AMERICAN ENGINEER tests of locomotive draft appliances, which is concluded in the current issue of your paper, I have no hesitation in characterizing this report as a record of one of the most ably conducted and practically valuable investigations in scientific locomotive engineering which has ever been carried out. It is alike worthy of Professor Goss and of the AMERICAN ENGINEER, to whose liberality and initiative these tests owe their existence. The report is a classic in its special department of science, but it is feared that in the future there will be many persons desirous of utilizing it, to whom the complete series of numbers of the AMERICAN ENGINEER containing the report will not be available. It is probable that this report will be of interest and value so long as the present type of steam locomotive exists, and in order that it shall be for all time readily available for reference and study, I beg leave to suggest through your columns to the executive committee of the Railway Master Mechanics' Association that, with your permission, this report be made of permanent record by publication next year in the proceedings of the association.

EDWARD L. COSTER,
Honorary Member Master Mechanics' Association.

25 Broad Street, New York, September 8, 1903.

SIDE BEARINGS FOR TENDERS.

To the Editors:

From what I can learn, the majority of railways never use any side bearings on the front trucks of tenders. I have looked this matter up, but have been unable to find any good reason for this established practice. I take the liberty of asking or suggesting that some time in the future you will give an article in your journal discussing the matter. I feel sure that others are in the dark on this question and that we will all be mutually benefited by it.

J. P. CALLIGAN.

Marshall, Texas.

Many railroads use side bearings on the leading trucks of tenders. Others have used and abandoned them, but with the advent of satisfactory roller and ball side bearings the practice will undoubtedly become general.

Side bearings of the usual type increase the difficulty of curving. Tenders are usually short, and it is possible for the side bearings on the rear trucks to prevent the rocking of the tender. Furthermore, the rear truck carries the greater part of the load. These are undoubtedly the reasons for the apparent abandonment of side bearings on front trucks which our correspondent has noted. They have not been abandoned, and are likely to appear in larger numbers in the future.—EDITORS.

THE BORING MILL THAT BROKE DOWN.

To the Editor:

I was much interested in the experience, noted on page 267 of the July issue of the AMERICAN ENGINEER (editorial correspondence), with a 96-in. boring mill at a large railroad shop, which proved to be "not strong enough." The case cited was one that does not speak well for the machine-tool builders, and moreover it brings up a subject that deserves more attention than it usually receives.

If correctly designed, the driving belt of a machine of this kind should be the weak point; and the belt should slip, even if quite tight, before the gears should break. But it is not surprising that this mill broke down. There were three things which especially contributed to the breakage:

First, the 10-h.p. motor—as usually designed for average work, boring mills of this size require about 3½ h.p. to drive, or, in extreme cases, 5 h.p. might be needed if the belt were kept very tight.

Second—five tires had already been bored before the "last straw." Now, it is safe to guess that the tool had become somewhat dulled, and it does not take much dulling when turning tire steel to cause a demand for double the power, or more, than when the tool is sharp. With the cutting tool in good condition and working with a feed of ⅛ in. and a depth of cut of 3-16 in., the power required would probably not be less than 5 h.p. for such material. This, with a tool considerably dulled, may have increased to 10 or 12 h.p. Under such conditions a belt would ordinarily have slipped on most

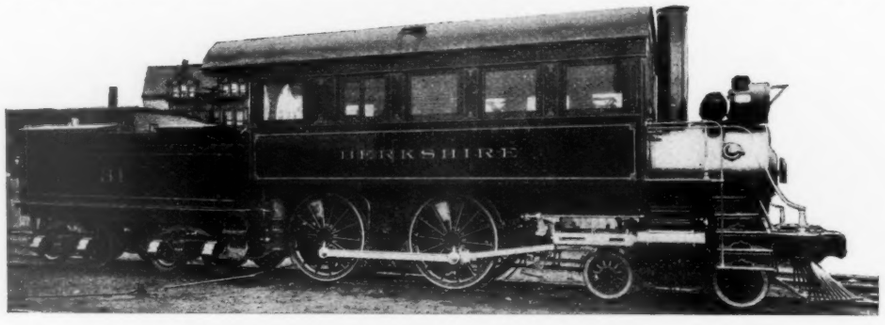
tools and forced a regrinding of the tool; but upon a good motor considerable additional load may be placed before it will lay down—in this case the motor held up and the gearing failed.

Third—the operator's ambition to "pile up tires," which, while we must commend it, was undoubtedly unfavorable, and if he had reground that tool, he would probably have spared the mill.

A word about those speeds: A range of 16 to 975 ft. per minute is a ratio of about 61 to 1; or, with a given cutting speed for the maximum diameter of 96 ins., the minimum diameter for same cutting speed would be 1.6 ins., approximately. This is a somewhat greater range than usual, and more than necessary, but not much more than some users demand. It is seldom that such an extreme range is needed, but sometimes a buyer thinks it necessary and "kicks" if he doesn't get it. I have seen 2-in. holes bored on a 10-ft. boring mill. As you stated, however, such a range seems unnecessary in this case, and it does look as though something were a little bit out. J. C. STEEN.

INSPECTION LOCOMOTIVE FOR THE BOSTON & ALBANY RAILROAD.

This new inspection locomotive was recently built at the Allston shops of this road and will be used by officials. The locomotive is an old one rebuilt, and is more powerful than those usually used in such service, being capable of hauling three heavy cars if necessary. A large 12 x 9-ft. observation room is provided over the boiler, and back of this are the engineer's cab and fireman's compartment. Special insulation was provided over the boiler to keep the observation room cool and the ventilation, by aid of a pneumatic fan, is unusually effective. Air ducts through the ceiling carry the outgoing air to the hood back of the car, fresh air being introduced through a regulating box in front. An Edwards equipment supplies current for an electric headlight and incandescents in the observation room and cab, as well as under the running board. The engine has the Westinghouse high-speed brake and also "straight air," with shoes on all the wheels. Throughout, the equipment is very complete. In the following table the chief dimensions are presented:



INSPECTION LOCOMOTIVE—BOSTON & ALBANY RAILROAD.

Observation room	9 by 12 ft.
Total wheel base of engine	21 ft. 8 ins.
Driver wheel base	93 ins.
Total wheel base, including tender	42 ft. 11 ins.
Cylinders	16 by 22 ins.
Drivers	60 ins.
Weight on drivers	50,000 lbs.
Total weight	78,000 lbs.
Boiler pressure	130 lbs.
Diameter of boiler	50 ins.
Total heating surface	1,048 sq. ft.
Grate area	16 sq. ft.

Between the Ocean and the Lakes. A new edition of this interesting and famous "History of the Erie Railroad," by Edward Harold Mott. Size, 10 x 12 ins., 550 pages. A complete new index added. Price reduced to $7.

We desire to call attention to the fact that this interesting volume is now being offered to our readers at a very much reduced price, which will bring it within the reach of all. This edition is similar in all essential features to the original work, the binding being of a rich quality, with gold edges and letters, and the typographical work is unexcelled. It may be opportune to state, for the benefit of those not familiar with the work, that it is in no sense a large advertisement of the Erie Railroad, being strictly a history of the early development of American railroading, in which the Erie played the most spectacular part of any. It has been a scene of an almost unbelievable amount of financial manipulation and scheming, all of which is revealed in the most interesting manner in this volume. We can heartily recommend the book to all who are interested in railroad history. The reader is referred to a more complete reference to the contents of this book, which appears in our advertising columns.

PERSONALS.

Mr. Robert Rennie has been appointed shop superintendent of the St. Louis & San Francisco at Springfield, Mo. He has been mechanical engineer of this road.

Mr. T. J. Cutler, master mechanic of the Northern Pacific at Glendive, Mont., has been transferred in the same capacity to Jamestown, N. D. He is succeeded at Glendive by Mr. C. E. Allen, traveling engineer.

Mr. Charles E. Fuller has resigned as assistant mechanical superintendent of the Erie to succeed Mr. A. L. Humphrey as superintendent of motive power of the Chicago & Alton, with headquarters at Bloomington, Ill.

Robert C. Blackall died suddenly at his home in Albany, August 31. He was a veteran of over fifty years' service in motive power work and one of the best-known members of the railroad mechanical associations. He was born in Albany in 1831 and spent all of his years of railroad work in the neighborhood of his boyhood home. Mr. Blackall was a past president of the Master Mechanics' Association and was honored and respected by an unusually large circle of friends. Four years ago he was retired from active service on the Delaware & Hudson, where he had served as superintendent of motive power for twenty-nine years.

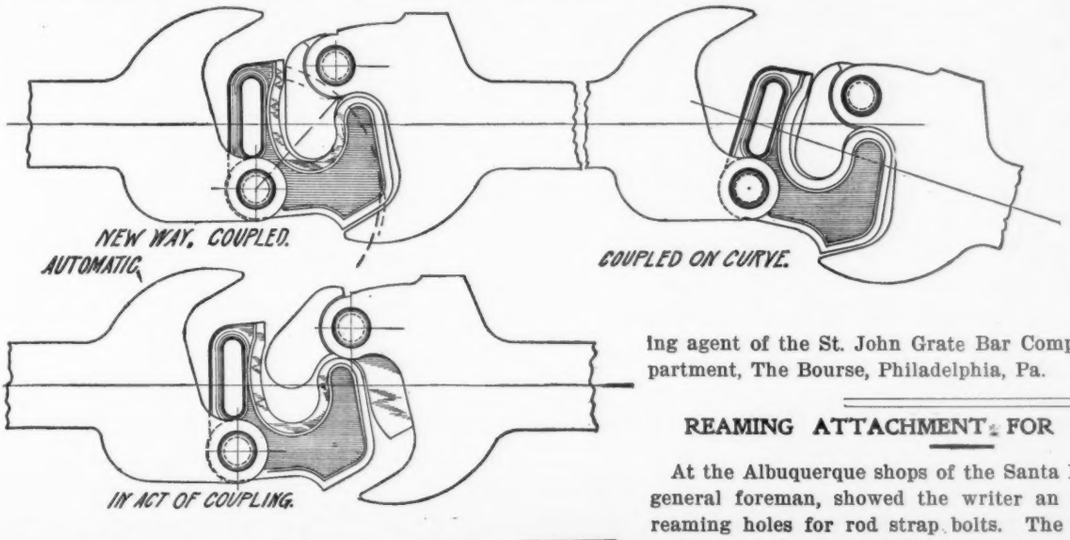
German papers report the discovery by a Frenchman named Mollard of a new metal called "selium." The discoverer claims that selium will cost but one-twelfth as much as aluminum and is lighter and stronger. It does not rust and is therefore suitable for use in shipbuilding, for the manufacture of pipes and for railroad construction. It is capable of a fine polish, resembling nickel. Its density is 2.6 and its hardness not quite that of iron, but greater than lead or zinc. Its power of resistance is said to be greater than that of iron, but less than that of steel.

Recent advices from the Walter A. Zelnicker Supply Company, 408 North Fourth street, St. Louis, Mo., indicate a very large business in their line of railroad supplies. In their daily bulletin, which is sent to all interested, are quoted large numbers of second-hand locomotives, passenger and freight cars of all kinds, wheels, relaying rails, steam shovels, machine tools, etc. In a recent bulletin we notice a brand-new 15-ton steel-car wrecking crane, which is offered at a very low price. It has only been completed a few weeks, and has never been in service.

RUBBER MATS, MATTING AND TREADS.—This is the title of a very comprehensive catalogue upon this subject that has just been received from the Boston Belting Company, 256 Devonshire street, Boston, Mass. This company has made a specialty of the manufacture of perforated door-mats, with initials, for railroad, sleeping-car, and private companies, and also solid matting, car-step treads, etc., a large number of samples being carefully illustrated in this pamphlet. The very complete line of solid and corrugated matting manufactured by the company is also well illustrated.

HINSON EMERGENCY KNUCKLE.

This device is intended for use in connecting automatic couplers in case of the breakage of one of the knuckles. The engravings illustrate its construction and application. It is adapted for use with all couplers which have the pivot pin and its outline is such as to couple automatically with all couplers of the M. C. B. lines. A handle is incorporated in

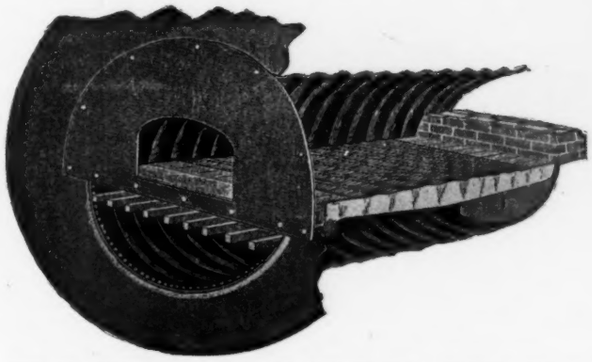


the casting in order to carry it about easily. These emergency knuckles are so formed as to insure against uncoupling in service. The knuckle must move about its pivot pin in order to uncouple and the arm carrying the handle bears against the face of the mating knuckle when coupled, which prevents such rotation. Obviously this coupling is more satisfactory than the link. Moreover, the use of such a device as this permits the abandonment of the knuckle slot and pin-hole which seriously weaken the knuckles of automatic couplers. This knuckle is manufactured by the National Car Coupler Company, of which Mr. J. A. Hinson is president. Further information may be obtained from the manufacturers, 525 Monadnock Block, Chicago.

THE ST. JOHN GRATE BAR.

The improved construction of grate bars which is embodied in the St. John grate bar has proved very successful in service in marine and stationary steam boilers. It is used on four United States naval cruisers and five battleships, as well as on steamers of the American Line and other lines.

The bars are rocked singly and independently by means of their projecting ends and are rocked alternately. By shaking



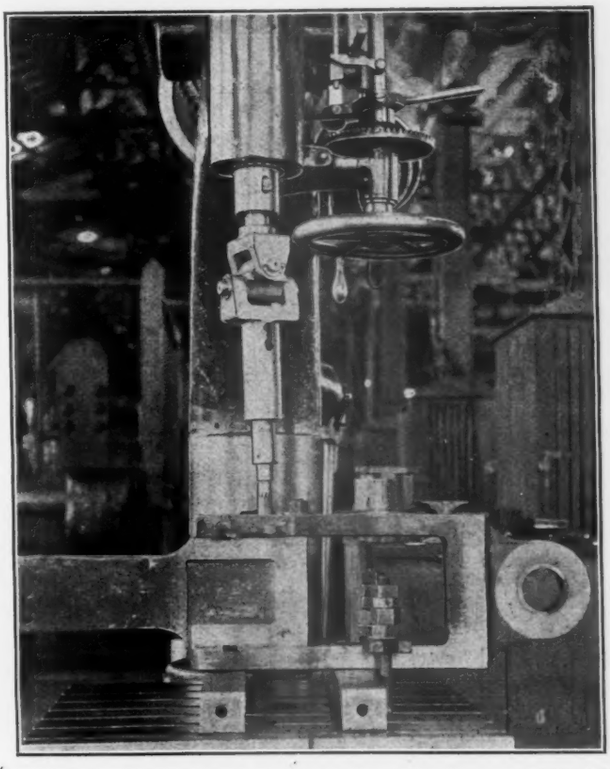
THE ST. JOHN GRATE BAR, AS APPLIED TO A MARINE BOILER.

the bottom of the fire evenly the clinker is carried to the ash pit as soon as possible instead of forcing it upward through the fire. The cutting effect is produced by the side cutting edges as well as the crests of the corrugations, the large surface of the fire not being disturbed as is the case with bars having a large lifting effect. By this construction a large air space is provided, which benefits the fire and increases the life of the bars. As these are trussed, they are strong and not liable to warp. It is stated that by using these grates a lower grade of fuel may be burned and the frequency of cleaning fires largely reduced. Clinker does not fasten itself to these grates and this is in itself a reason for long life, as well as economy of fuel.

The engraving illustrates the application to a marine furnace, where the qualities of grates are more severely tested than in any service, except possibly that of locomotives. This is unquestionably a good grate bar. Further information may be had from Mr. A. B. Willoughby, selling agent of the St. John Grate Bar Company, Machinery Department, The Bourse, Philadelphia, Pa.

REAMING ATTACHMENT FOR ROD STRAPS.

At the Albuquerque shops of the Santa Fe, Mr. W. L. Essex, general foreman, showed the writer an excellent device for reaming holes for rod strap bolts. The expense of reaming these holes by hand led to experiments upon driving the reamer by power in an ordinary drill press. In such work it is essential that the reamer should "float" and be unrestrained



DEVICE FOR REAMING ROD STRAPS.

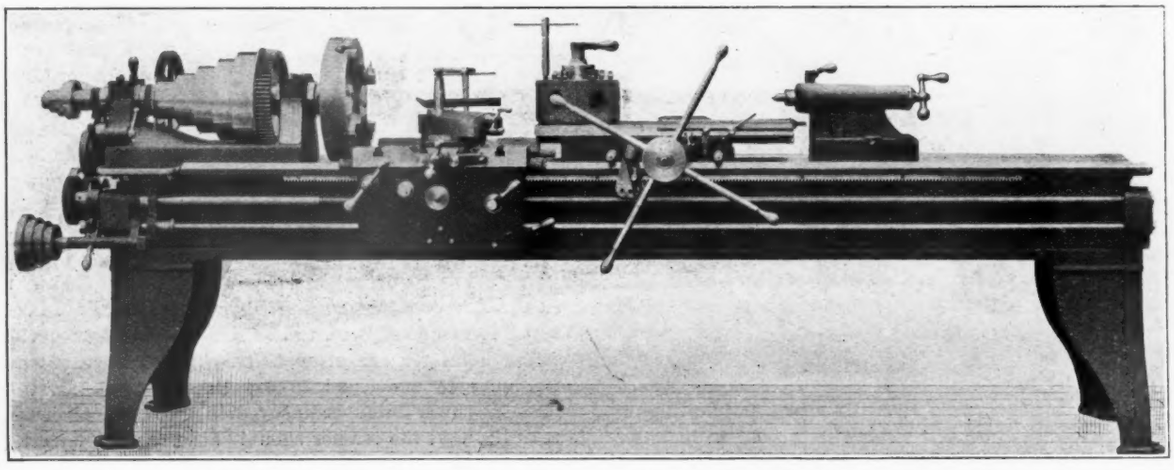
and free from constraint of the machine as to alignment. This is provided in this attachment by a universal joint, the construction of which is clearly seen in the accompanying engraving. The upper and lower shanks of the jointed part fit the spindle of the machine and the reamer with the usual tapers. Special care in leveling the rod does not seem to be at all necessary, and the results are all that may be desired. The drill press is made ready and the work set up in about ten minutes. It then requires about fifteen to twenty minutes to ream a hole. Doubtless this time will be very much reduced as the men become accustomed to the work.

AN INTERESTING NEW 17-INCH ENGINE LATHE.

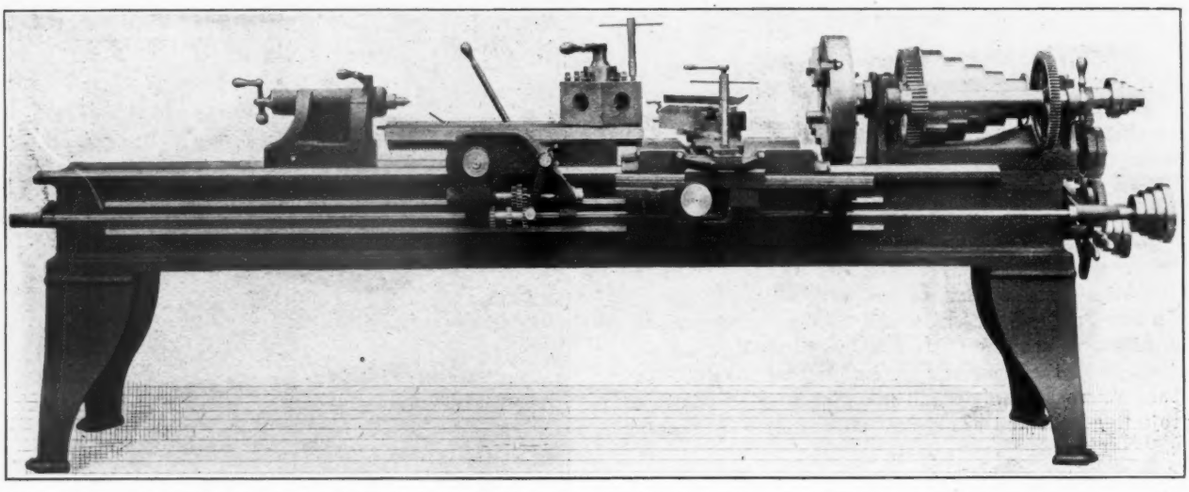
With Power-Feed Automatic Turret on the Shears.

GREAVES, KLUSMAN & CO.

We desire to call attention to a new design of engine lathe which has recently been perfected by Greaves, Klusman & Co., Cincinnati, Ohio, for the reason of the large number of modern labor-saving attachments that have been incorporated and also the application of an automatic power-feed turret on the shears, for rapid duplicate manufacturing, which is becoming so very important in large railroad shop practice. A lathe of the type illustrated herewith is particularly adapted for use in railroad shops, inasmuch as it can so easily be changed over for either plain lathe work or for rapid duplicate manufacturing. This is an important feature, as in many of the smaller shops it might not pay to have a separate turret lathe, while a duplicate machine of this kind could easily be afforded, as it would never need to be idle.



A NEW DESIGN OF ENGINE LATHE, WITH AUTOMATIC POWER-FEED TURRET ATTACHMENT.



REAR VIEW OF THE LATHE, SHOWING TURRET MECHANISM AND TAPER-TURNING ATTACHMENT.
GREAVES, KLUSMAN & CO.

Two illustrations are presented, one a front view and the other a rear view. As may be seen at a glance from its general appearance, this lathe is well proportioned and is apparently well equipped for the heaviest work within its range. The builders inform us that all parts have been newly designed and that an entirely new set of patterns were provided—this to enable the tool to be brought up to the strength required by the new high-speed tool-steel practice.

Both the headstock and the tailstock are built very heavy, and the spindle is large and is finished by grinding to ensure absolute truth of round. The carriage has a bearing throughout its entire length on all four of the V-ways to provide ample rigidity. The design of the apron mechanism is most up-to-date and improved, embodying an arrangement whereby all feeds are reversed at that point and also a safety device to prevent both the rod and the screw feeds being thrown in at the same time. An index dial arrangement is provided on the carriage, in connection with the lead screw, to take care of thread cutting, so that there is no necessity of reversing the lathe when running the threading tool back for another cut.

A full range of geared feeds are provided by the change gears, and without the use of the lead screw; there is also a belt feed, having four cone changes, and the feeds may be operated by either belt or gearing, without disconnecting either. Threads may be cut from 2 to 48 per inch, either right or left, without changing any gears. The friction cross-feed is graduated to one-thousandths of an inch and is so arranged that if it is allowed to run beyond its limit no harm will be done—an important feature for the cross feed.

The turret design is heavy and rigid and is calculated to provide for heavy and rapid machining. It is arranged entirely different from prevalent designs, and combines many features of advantage. In addition to the regular feed cone changes, it has in itself three changes of feed, which are directly under the control of the operator, from the front side of the turret by a lever next to the pilot wheel. The builders provide either a round or hexagonal turret for use on this lathe, as desired.

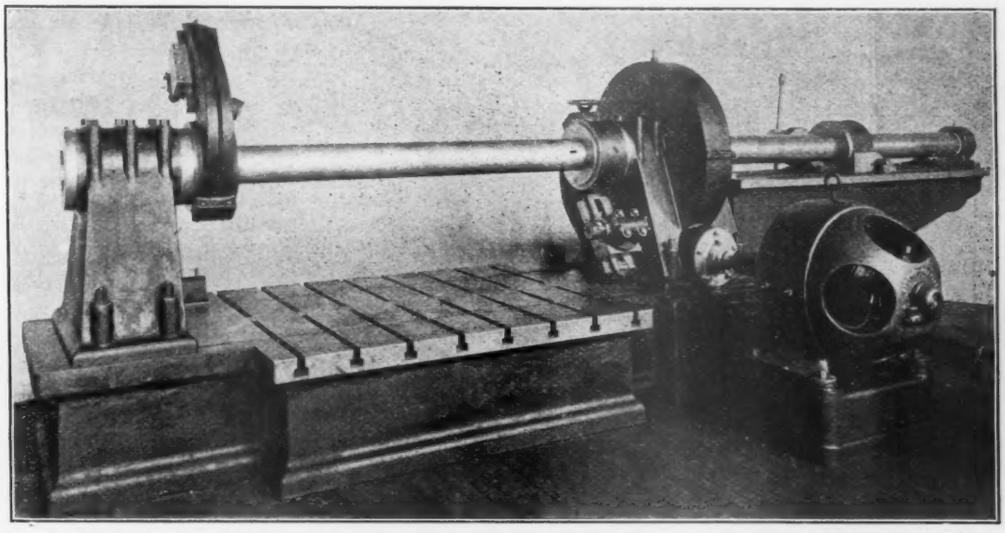
The principal dimensions of this interesting tool are as follows:

Length of bed (6-ft. lathe)	6 ft. 5 ins.
Swing over bed	17¼ ins.
Swing over carriage	9¾ ins.
Will turn in length	2 ft. 10 ins.
Will turn in length, with tailstock extended	3 ft. 2 ins.
Ratio of back gearing	12 to 1
Front spindle bearing, Diameter, 2 13-16 ins.; length,	4¾ ins.
Rear spindle bearing, Diameter, 2¼ ins.. length,	4¼ ins.
Hole in spindle	1 7-16 ins.
Compound rest travel	4 ins.
Head cone pulley: 2⅝ ins. face; 4¾, 6½, 8¼, 10 and 11¾ ins. diameter	
Weight of lathe, with 6-ft. bed and turret	2,400 lbs.
Weight of bed, per foot	115 lbs.

AN INTERESTING MOTOR-DRIVE FOR A HORIZONTAL BORING MACHINE.

At the time when individual motor driving for machine tools was first coming into use, motor applications were made that, in the light of present practice, would be regarded as crude to say the least. But, later, with the benefit of previous experience, the number of creditable designs of motor driving increased, until now it is exceptional to meet with a new arrangement which does not possess a fair quota of commendable features. But even among the most approved designs of the present day, seldom is so simple and commendable an arrangement encountered as the one employed on the drive of the horizontal boring machine illustrated herewith.

The tool is a No. 3 Barret boring machine, similar in all particulars to the belt-driven style, except that the cone pulley is replaced by a Crocker-Wheeler 13-h.p. multiple-voltage system motor, mounted on a special cast-iron base which is bolted to the bed of the machine proper. The equipment occupies a floor space over all of 18 ft. 1½ ins. long (exclusive of the projection of the boring bar), by 7 ft. 4 ins. wide. The boring bar is 6 ins. in diameter and 16 ft. 8 ins. long. An Albro worm and worm gear with a ratio of 70 to 1 transmits power from the motor, thus affording a very smooth and even motion to the boring bar, particularly desirable in cylinder boring and similar work. The worm and worm gear are encased in one casting, which protects the gears and also, with by means of a stuffing box surrounding the worm shaft, retains the lubricating oil.



A REMARKABLY SIMPLE ARRANGEMENT FOR ELECTRIC DRIVING UPON A BARRET BORING MACHINE.—13-H. P. CROCKER-WHEELER MULTIPLE VOLTAGE MOTOR.

The bearings in the pedestals supporting the boring bar have their centers 24 ins. above the bed and are bored out 9 ins. in diameter to provide for sleeves, which are fixed against endwise displacement but are provided with feathers which engage the keyway extending the length of the splined boring bar so as to cause all to rotate simultaneously. The arms, which carry facing blocks, are mounted on extensions of the sleeves between the pedestals. The latter support the facing tools and are arranged to feed axially or at right angles thereto.

For inside boring a cutting head, not shown, is secured to the boring bar, the feeding being accomplished by sliding the whole bar endwise. The extended frame shown at the right of the machine with a third bearing at its outer extremity contributes to the rigidity of the bar and supports the feeding mechanism, which consists of a slidable carriage containing a sleeve that revolves with the boring bar and may be secured to it at any point, so that any shifting of the carriage causes a lengthwise movement of the boring bar.

The drive to the tool has only one speed reduction, but the machine has a range of twelve speeds in either direction, varying from 2 2-7 to 15 3-7 rev. per min., secured by speed control of the motor. The motor is wound for the Crocker-Wheeler multiple-voltage system, whereby six fundamental speeds are obtained by different voltage combinations, increasing by increments of 40 from zero to 240 volts and the six intermediate speeds through the use of a small resistance between each fundamental step.

The Barret boring machine is built by the Meadville Vise Company, Meadville, Pa., and the motor applied is a size 10-I shunt motor, semi-enclosed type, supplied by the Crocker-Wheeler Company, Ampere, N. J.

For an increase in speed of a single knot per hour, it is necessary to add 30 ft. to the length of a 25-knot ship, and to add 16,000 h. p. in the machinery, also 1,255 additional tons of coal must be provided. This would involve increasing the displacement by 3,100 tons and adding 80 men to the engineer's staff. The increased cost would be $1,250,000. Recent negotiations between the Cunard Company and the British admiralty concerning the building of two new 25-knot vessels developed an estimate of the comparative costs of construction and operation of 20 and 26-knot vessels, the investigation being based on a 20-knot ship 600 ft. long, with 19,000 h. p. and consuming 2,228 tons of coal in a single trip. Such a ship would cost $1,750,000. A 23-knot vessel would be 690 ft. long, would require 30,000 h. p., and would cost $2,875,000. A 25-knot vessel would be 750 ft. long, would require 52,000 h. p. and would cost $5,000,000. A 26-knot steamer would need to be 780 ft long and require 68,000 h. p., the cost being $6,250,000. The engineer's force on a 20-knot steamer numbers 100; a 23-knot 150 men; a 25-knot, 260 men and a 26-knot, 340 men. These interesting figures showing the price which must be paid for high speeds at sea are taken from the *Scientific American*.

A gas engine of 3,000 h.p. is promised as a feature of the approaching World's Fair at St. Louis. It will be exhibited by the John Cockerill Company, Seraing, Belgium, and will be direct-connected to an electric generator.

MASTER STEAM BOILER MAKERS' ASSOCIATION.

This organization will hold its second annual convention in the Palmer House, Chicago, October 7 to 10. A large attendance of superintendents, foremen, assistants and "layer-outs" is expected.

A NEW DESIGN OF MULTIPLE-SPINDLE MUD-RING AND FLUE-SHEET DRILL.

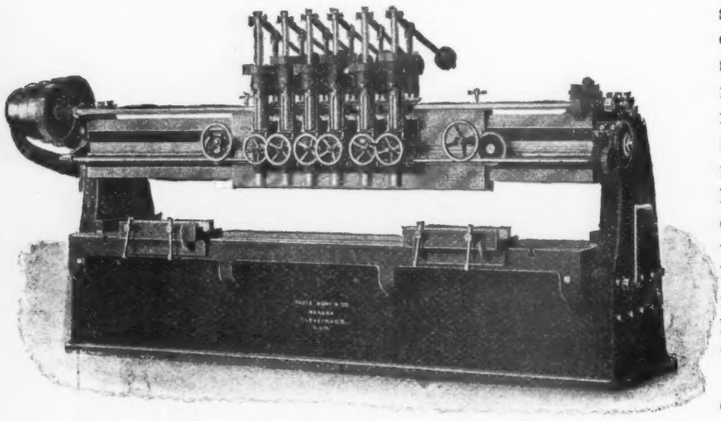
For Locomotive Work.

FOOTE, BURT & COMPANY.

This drill, which is shown in the halftone presented herewith, has been designed especially for mud-ring and flue-sheet drilling on locomotive work, although it is also suitable for any other type of multiple drilling.

The distinctive feature of this tool lies in mounting the six independently-fed heads, which are adjustable in their center distance, on an auxiliary cross rail, this cross rail, in turn, being adjustable the entire length of the main cross rail. By this means a mud ring can be dropped into the two chucks shown on table and securely clamped, and then without moving the work in these chucks, either one or two rows of rivet holes can be drilled the entire length at any spacing desired.

All that is necessary is to set the heads on the auxiliary crossrail at any given multiple of the desired pitch of the rivet holes. For instance: if the rivet holes are to come at 2-inch centers, the heads are set at 6-inch centers, and six holes drilled simultaneously; then the auxiliary crossrail, carrying the six heads, is moved 2 inches and six more holes are drilled,



NEW 6-SPINDLE MUD-RING AND FLUE-SHEET DRILL.
WITH AUXILIARY CROSS RAIL.
FOOTE, BURT & CO.

the operation being repeated the entire length of either mud ring or flue sheet. In case there are two rows of holes in the mud ring, after the first row is completed, the table is merely adjusted out or in, as the case might be, to whatever distance is required between the two rows of holes, and then the drilling operation can be repeated. For flue-sheet work, the same mode of operation would be pursued, the chucks having been first removed from the table.

The drill is provided with four spindle speeds and three feeds, and weighs, as shown, about 17,500 pounds. The manufacturers are Foote, Burt & Company, Cleveland, Ohio.

SPECIFICATIONS OF THE FOOTE, BURT & CO. MUD-RING DRILL.

Minimum distance between spindles....6 ins.
Maximum distance between spindles...12 ins.
Distance between housings.....12 ft. 4 ins.
Length of auxiliary cross rail.....6 ft.
Dimensions of table....12 ft. 4 ins. x 24 ins.
Cross Adjustment of table.....24 ins.

The coal-handling machinery installed by the C. W. Hunt Company at the Lincoln Wharf power station of the Boston Elevated Railroad recently made a new record for rapid unloading. The coal was raised 90 ft. above tidewater and delivered to the storage pockets at the rate of 320 tons per hour. The installation follows in general design the standard Hunt steeple-tower rig, the moving gear and coal cracker being electrically driven and the hoisting engine direct-connected. The folding boom has an overhang of 40 ft. and the capacity of the shovel is 2 tons.

PISTON VALVES IN DRIFTING.

The report of the committee on lubrication of piston rods presented to the Traveling Engineers' Association records an interesting experiment to ascertain the effect of allowing a locomotive to drift with the reverse lever "hooked up," and thus test the recommendation made before the Master Mechanics' Association.

"After the engine had worked steam constantly from Scranton to Gouldsboro, a distance of 21 miles and a grade of 60 ft. to the mile, steam pressure maintained at 205 lbs. the entire distance, I applied an alloy that melts at 286 degs. to the piston rod on arrival at Gouldsboro, but it would not melt. After shutting off the steam and drifting down the mountain I left the reverse lever in working notch. The speed ranged from 25 to 32 miles per hour. The distance the engine drifted was 24 miles, when speed was reduced to about 25 miles per hour. Relief valves opened only a very short space of time and only just a very small opening as the engine was passing the centers. When speed was above 25 miles per hour the relief valves did **not** open at all. When about half way down the mountain I could smell the cylinders heating up. I applied engine oil to the piston rods and a cloud of smoke arose from them. When about three-fourths of the way down the mountain I applied an alloy that melts at 286 degs. temperature to the outside of cylinder directly over the steam passage to the front end of cylinder, but the contact was rather poor on account of the scale on the metal. Nevertheless it melted. On arrival at the foot of the mountain we stopped and I applied the alloy that melts at 310 degs. to the piston rod and it melted in 5 seconds. I applied an alloy that melts at 334 degs. and it came very near melting. It softened up so that the lead pencil with which I held it to the rod made an indentation in the metal. This engine's valves were blowing quite badly at the time this test was made; otherwise I am sure that the temperature would have been raised very much higher. It was also evident to me that if the speed had been increased to 50 or 60 miles per hour the temperature in cylinders would have been so high that lubrication would have been of no benefit.

"On the next trip I experimented on the same lines with the exception of dropping the reverse lever to the corner while drifting, and at no time could the 286-deg. alloy be melted, not even on piston rod at foot of mountain. This practice of leaving the reverse lever in the working notch while drifting may not work any serious results if only practiced while drifting into stations, making stops, but I am satisfied that it will not work on long descending grades, especially at high speed. It certainly will result in cut cylinders and valves, as you can get no benefit from the lubrication on account of the increasing temperature caused by excessive compression. In my opinion the only way to keep the reverse lever in working notch when drifting is by the adoption of some automatic valve arrangement for relieving compression."

Development of the by-product coke ovens would seem to offer the solution of the problem of furnishing gaseous fuel at a low rate of cost, and methods of distribution to comparatively long distances make it possible to locate the producing plants at convenient geographical and commercial points. That there is a great waste of fuel where the gas from the ovens is not utilized is shown by figures given for the beehive ovens between Altoona and Pittsburg. These ovens probably make 20,000 tons of coke per day, from which about 100,000,000 cubic feet of gas discharge into the air. This gas, if converted into power through gas engines, would represent 5,000,000 h.p. hours, or the effort of about 104 gas engines of 2,000 h.p. each. Manufacturers of gas apparatus are now offering to guarantee the production of a horsepower hour for 1 lb. of fuel—a result not at present attainable through the medium of steam engines and boilers, except by the most complex type of engine.—*H. G. Morris, before Engineers' Club of Philadelphia.*

BOOKS AND PAMPHLETS.

The Drafting of Cams. By Louis Rouillon, Instructor in Mechanical Drawing at Columbia University. 23 pages, 6 x 9 ins., in pamphlet form. The second of a series of practical papers, published by the Derry-Collard Company, 256 Broadway, New York. Price 25 cents.

The important subject of cam design is elucidated in a most commendable manner in this pamphlet by a clear explanation of the principles involved and the citation of methods of treatment for a number of practical examples. The two methods of laying out a heart-shaped cam are used to illustrate the general method. This is followed by a treatise of the more difficult cam problems—those whose lines of action are not central with the cam axis. The treatise ends with the problem of the design of a cam belt-shifter to automatically shift the belts of an iron planer at reversals of motion of the platen. The latter is one of the problems in machine design regularly given to the students in Mechanical Engineering at Cornell University, and involves very interesting study. This work deserves to be especially recommended owing to the wide experience of the author, not only in the line of practical work, but also in the problem of instruction in drawing. The typographical work and paper used in the pamphlet are of the highest order, making a beautiful result. This pamphlet is to be followed by others of equal interest on important engineering subjects. Further information upon the subject may be obtained from the Derry-Collard Company.

The Art of Pattern-Making. A comprehensive treatise, with numerous examples of all kinds of pattern work. By I. McKim Chase, M.E. 260 pages, 12mo, cloth, and 215 figures. 1903. Published by John Wiley & Sons, 43 East Nineteenth street, New York. Price $2.50.

This is a work the advent of which will be welcomed by those interested in the important subject of pattern-making. As stated in the preface, "the literature pertaining to pattern-making is by no means as extensive as the importance of the business warrants," and the lack has long been felt. The author has, in presenting this work, endeavored to record the results of his long and extensive experience, the majority of the practical examples given being taken from his personal experience. These are, however, supplemented by further practical examples drawn from the experience of others, and from those that have appeared in the technical press. The work begins with a considerable space devoted to the equipment and management of a pattern shop, after which is presented the very comprehensive series of examples of practical pattern work for all classes of molding, from pipe elbows to complicated cylinder castings and screw propellers, cast whole or with separable blades. Considerable attention is paid to the important subject of core-box work, several excellent examples being given. The interest that the author has taken in his life work is evidenced in a remarkable manner in this book and we believe it will be found a desirable acquisition to pattern-making literature.

Universal Directory of Railway Officials, 1903. Compiled from Official Sources under the direction of S. Richardson Blundstone, editor of the *Railway Engineer*. Published by the Directory Publishing Company, 3 Ludgate Circus, London, E. C. Representative for the United States, E. A. Simmons, 1333 Broadway, Brooklyn, N. Y.

This is the ninth annual edition of this valuable directory of the principal railway officials of the world. It has been enlarged as well as revised and now includes practically all the railways and tramways operated by power in the United Kingdom. In addition to the names of officials the book includes information concerning the length and equipment of every railroad. It is invaluable to those who have correspondence or dealings of any kind with railway officials.

British Standard Sections. Issued in pamphlet form by the Engineering Standard Committee (England). D. Van Nostrand Company, 23 Murray street, New York. Price $1.

This publication consists of nine lithograph sheets in pamphlet form and contains the dimensions, thickness and profiles of the standard structural sections, that are recommended by the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, and the Institution of Electrical Engineers. The moments of inertia and other important properties of these sections are to be issued at a later date. American engineers will note particularly the large size angles and Z-bars contained in the list, the largest angle being 10 ins. x 4 ins., and the largest Z-bar, 10 ins. x 3½ ins. x 3½ ins. American builders may find this pamphlet a useful guide whenever the condition of the market makes it desirable to purchase English steel.

Railway Carriages and Wagons, Their Design and Construction. By Sidney Stone, Assistant Works Manager, Great Central Railway, England. Part I. Illustrated, 176 pages, 9 x 12 ins. in size. Published by the *Railway Engineer*, 3 Ludgate Circus Building, E. C., London, England. Price, 10s. 6d.

This is the fourth work by these publishers in the Railway Series of Text-Books and Manuals by Railway Men for Railway Men and Others. It is a series of articles contributed by the author to the pages of the *Railway Engineer*, rewritten for the purpose of filling the need for a standard book on this subject. It represents English practice in car construction and includes a large number of excellent photographs and reproductions of working drawings. The author begins with a study of woods. Wood working machinery is next considered and underframes taken up. Buffers, draw gear and iron details; wheels, axles and journal boxes; trucks and flexible wheel bases and continuous brakes follow in order. It is an excellent record of present English practice, with frequent references to methods used in the United States. While most valuable to foreign engineers and railroad men, it permits of making a careful study of light and strong construction in cars which might be made with advantage by those who are concerned in the very heavy construction used in this country.

The Star Improved Steam Engine Indicator. By Geo. H. Barrus, Expert and Consulting Steam Engineer. 140 pages, 12mo, cloth, fully illustrated. 1903. Published by the Star Brass Manufacturing Company, 108-114 East Dedham street, Boston, Mass. Price $1.00.

This is a treatise upon the principles and management of the steam engine indicator, which was prepared for the Star Brass Company, manufacturers of the well-known Star indicator. It is, in one sense, an advertisement of this particular make of indicator, but nevertheless the treatment of the subject takes the form of an unbiased statement of the important principles and the book contains much that is useful in indicator practice. A large portion of the work is devoted to a complete description of this particular instrument, while the latter part tells how to indicate an engine and make the necessary calculations. A large number of sample cards are shown, nearly all of which were taken personally by the author with the new Star indicator for this treatise. This book may be had either from the D. Van Nostrand Company, 23 Murray street, New York, or from the author at 12 Pemberton Square, Boston, Mass.

INDEX OF THE TECHNICAL PRESS.—The fourth number of this pamphlet has been received and is four times the size of the first number, indicating marked progress in value. The references are in French, German and English and include the principal articles of general interest appearing in the technical journals throughout the world. The work is well done and the classification excellent. It is published by the Association de la Press Technique, 20 Rue de la Chancellerie, Brussels, Belgium.

SPECIFICATIONS FOR PORTLAND AND NATIONAL CEMENT AND PORTLAND CEMENT CONCRETE.—The American Railway Engineering and Maintenance of Way Association has prepared the specifications, adopted this year, in pamphlet form. The pamphlet also contains specifications for concrete, submitted by the committee on masonry, but not yet adopted. Copies may be obtained from the secretary, Mr. E. H. Fritch, room 1562, Monadnock Block, Chicago. Price 10 cents.

SMALL TOOLS, STANDARDS AND GAUGES.—This is the title of a very complete catalogue of the small tools for machine shop use and also special tools which are manufactured by the Small Tool Department of the Pratt & Whitney Company, Hartford, Conn. It is of a handbook size, contains 182 pages, and is profusely illustrated by excellent engravings. A large portion of the book is taken up by descriptions of the very complete assortment of taps and dies which this company is noted for. Besides the usual hand taps of all standards a specialty is made of washout-hole-plug taps, staybolt taps and spindle retapping staybolt taps for locomotive boiler use. Also a large assortment of special patent dies and also die stock sets are illustrated. The stock of milling cutters, both solid and with inserted blades, angle cutters, slotting cutters, end and hollow mills, and also reamers of all styles and for all purposes may be seen to be very large. The remaining portion of the book illustrates a number of special tools which the Pratt & Whitney Company make a specialty of, including the Renshaw ratchet drill, the P. & W. special threading tool, special boring, knurling and other tools for lathe use, standard punches and dies for boiler plate work, etc., etc., and also a complete line of standard measuring machines, standard size and thread gauges, and gauges for special purposes, as for M. C. B. standard automatic couplers, new and worn knuckles, and flange thickness and wheel defect gauges.

THE NATIONAL MACHINE TOOL COMPANY.—A new catalogue has been issued by this firm to describe their improved portable keyseating tools, which they have lately placed on the market for use in connection with the drill press. This interesting and remarkable device is meeting with unusual success and approval in all quarters, for its simplicity as well as its efficiency. It is adapted to the cutting of internal keyseats of all sizes, both straight and taper, and in all metals. It is interesting to note that this very useful tool was developed by Mr. Schellenbach, of the National Machine Tool Company, as a special tool for use in the manufacture of their mechanical speed variators, a complete description of which was presented on page 229 of our June, 1903, issue. For cutting the keyseats in the large number of gears used in that device this tool has proven unusually effective and efficient.

PRECISION LATHES.—The Pratt & Whitney Company, Hartford, Conn., have just issued one of their standard 6 x 9 catalogues, which is devoted to their bench lathe, 10-in. toolmakers' lathe, 13-in. engine lathe and 14-in. gibbed-carriage engine lathe. The book contains 67 pages and is beautifully illustrated with excellent halftones. The first thirty-seven pages are taken up with a description of the 7 x 32-in. bench lathe, which is described in detail, and illustrations are presented of more than thirty of the various attachments which may be furnished with the lathe, giving an adequate idea of the great diversity of work for which this machine is adapted. The 10-in. toolmakers' lathe is also carefully described, and illustrations are given showing the application of collets and split step chucks to the spindle. There are two views of the 14-in. lathe, one showing the standard lathe and the other the lathe with the pan bed. A number of important attachments for this lathe are illustrated and described, including a relieving attachment for relieving straight, taper and spiral taps and milling cutters, drawback collets, step chucks and closers, and expanding arbors. These lathes perhaps are not applicable to the ordinary run of shop practice, but to anyone who cares for good machines, or who has to do accurate work, they will certainly be highly appreciated.

The Bureau of Forestry, United States Department of Agriculture, has inaugurated an investigation of the mechanical properties of the commercial timbers of the United States, and has established a timber-testing station at Purdue University, Lafayette, Ind., to form the nucleus of the work in the Mississippi Valley region. Other stations have been established at the University of California, at the Yale Forest School, and at Washington, D. C. Various physical and mechanical tests will be made according to uniform methods at these stations by experts of the Bureau of Forestry. This action of the bureau in establishing a testing station at Purdue University does not involve the erection of additional buildings, but a more thorough utilization of equipment already existing in the laboratory for testing materials. Additional machines of a special character, however, belonging to the bureau, will be installed in the laboratory for the needs of this work. The work of this station will be under the direction of Dr. W. K. Hatt, who has recently been appointed to have supervisory charge of the work of all the timber-testing stations of the Bureau of Forestry. Responsibilities thus assumed by Dr. Hatt will not interfere with the discharge of his duties at Purdue University.

EQUIPMENT AND MANUFACTURING NOTES.

Mr. Walter D. Crosman, who is well known from his long connection with railway newspaper work and association with railway supply business, has opened an office in suite 710, 125 La Salle street, Chicago. He will serve the railway and allied trades with the Wachter Manufacturing Company's Army and Navy liquid glue, the Wilbern adjustable door-hanger, and the Wadsworth-Howland Company's carburet black. We join Mr. Crosman's many friends in wishing him the success which his wide acquaintance and knowledge of railroad requirements are sure to bring him.

Judge Archibald, of the United States Circuit Court, Eastern District, Pennsylvania, has recently handed down a decision in the suit of the Westinghouse Electric and Manufacturing Company against H. C. Roberts and the Sangamo Electric Company which has an important bearing upon alternating current meters and fan motors, in that the claims of the so-called Tesla Split-Phase patents were sustained. The defendants' device against which suit was brought was the Sangamo meter. The court, after a careful review of the testimony, decided that the complainants had satisfactorily proved that Tesla's date of invention preceded that of Farraris and others, and that the device in question was an infringement.

The Washburn Coupler Company, of Minneapolis, Minn., announces that its stock, property and business have been acquired by the Washburn Company, of that city. The change of ownership is made in order to extend the business in car couplers and other lines of railroad supplies and does not involve any great changes in the management.

An interesting shipment of large steam turbine machinery has recently been made from the shops of the Westinghouse Machine Company, Pittsburgh, Pa., which will be the first large steam turbines of American manufacture to be exported. The shipment consisted of two 1,000-kw. Westinghouse turbine generating units of the most recent design, which are intended for light and power service in the De Beers mines, at Kimberly, South Africa.

The New York offices of the sales organization of the Westinghouse Electric and Manufacturing Company have been removed to the new Hanover Bank Building, corner of Nassau and Pine streets. The new offices occupy the entire seventeenth floor of this building, one of the finest and best equipped office buildings in the country, where the arrangements and facilities will be of the best, both for the representatives of the company and the public with whom they do business. The mail address will be No. 11 Pine street. The executive, financial and stock transfer offices of the company will remain on the fourth floor of the Equitable Building, in which the present organization of the company has been quartered since 1889. The rapid and material increase of business has made the above move necessary.

The Chicago Pneumatic Tool Company requests the publication of the following statement:

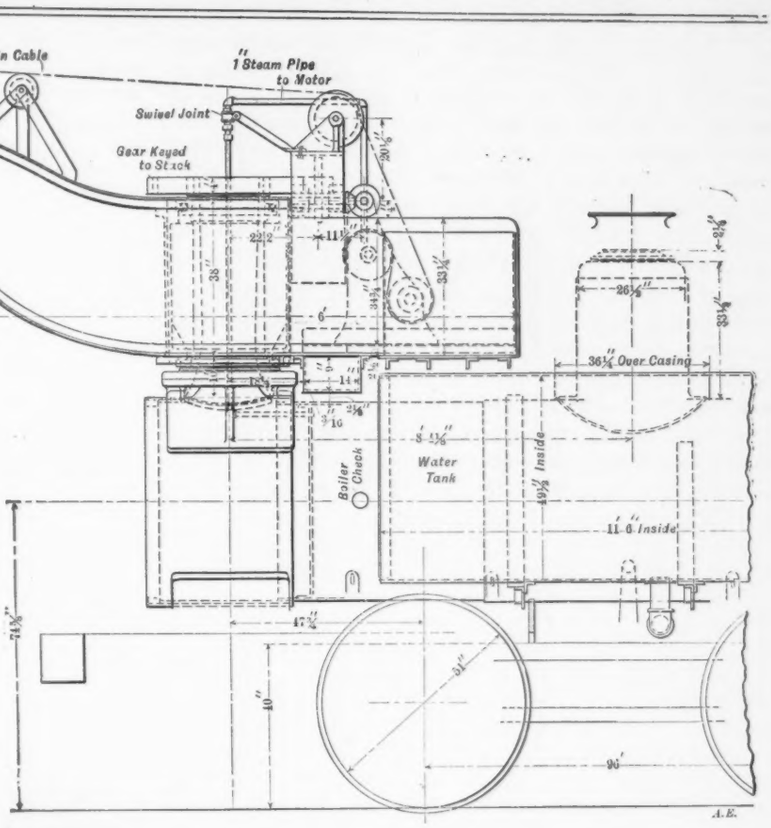
"During the past few days a vast amount of gossip has been printed relative to this company, the majority of which was entirely without foundation and apparently malicious in nature. As it does a great injustice to the company and its officials, we would request that you print the following statement which is in every respect a true and correct statement of the affairs of the company:

"In the first place President Duntley is not going to resign. It is due to his knowledge, energy and ability that the pneumatic tool business has grown to its present vast proportions. This is fully recognized by the directors and none of them desire his resignation. The report that he does not have the confidence of Mr. Schwab or Mr. Matthiessen is entirely without foundation and there is no justification in the report that he anticipates retiring or that any stockholders desire him to do so. The fact that Mr. Schwab has purchased from Mr. Pam the stock owned by the latter is true and this transaction was a private one between them. It originated with them and none of the other officers or stockholders have anything to do with it. Therefore, Mr. Pam having sold all of his stock, it naturally followed that he should resign from the directory, which he has done entirely of his own accord. The executive offices of the company are to be moved to New York and it is due to this fact that some of the directors have tendered their resignations. Mr. Schwab is the largest stockholder in the company and has expressed a desire to take an active part in the direction of the company's business, as has also Mr. Matthiessen. Their action is entirely justified by their present holdings in the company, and as they both live in New York, it is necessary that the executive offices be located in that city.

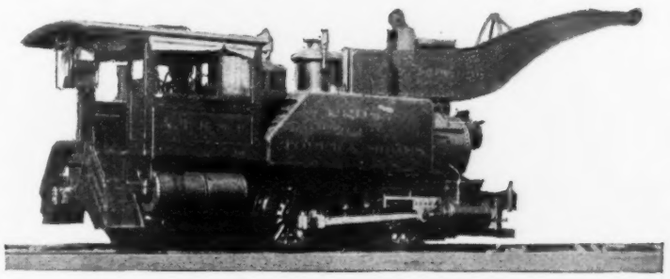
"As regards Messrs. Wacker, Chalmers and Lynch, these gentlemen agreed when they accepted places on the board that they would do so only if the executive offices were located in Chicago, as it would be impossible for them to attend meetings in New York City, as they could not take the time from their other affairs. Naturally, therefore, when they learned of the proposed change in location, they were opposed to it, as they felt it impracticable for them to continue on the board and executive committee, and they accordingly tendered their resignations. In all probability the number of directors will be reduced from fifteen to nine, as the members are widely separated and it is difficult to obtain a quorum with the present number. The affairs of the company are in a most flourishing condition and the prospects are exceedingly bright for them to continue so in the future. The various plants are working increased forces in order to adequately fulfill the requirements. Their foreign offices report a correspondingly cheerful outlook. The business for the month of August just past exceeded that transacted in August, 1902, and there is every indication that the present month of September will be very satisfactory as regards sales of pneumatic appliances."

A SWITCH ENGINE WITH A CRANE.

A convenient locomotive crane of 4 tons lifting capacity has been fitted up at comparatively little expense at the Topeka shops of the Atchison, Topeka & Santa Fe and will be used about the locomotive shops and yards. An old four-wheel switch engine was equipped to burn oil (so that it may safely enter the buildings) and fitted with a substantial castiron stack with a large base, forming the pivot and support of a 14-ft. boom. The boom may be revolved and the hook raised, by power. The steam pipe for the hoisting engine passes through the center of the stack and has a swivel joint over the stack. Ball bearings are provided for the boom pivot.



DETAILS OF THE CRANE, INDICATING ARRANGEMENT OF HOISTING AND TURNING MECHANISM.



GENERAL VIEW OF ENGINE.

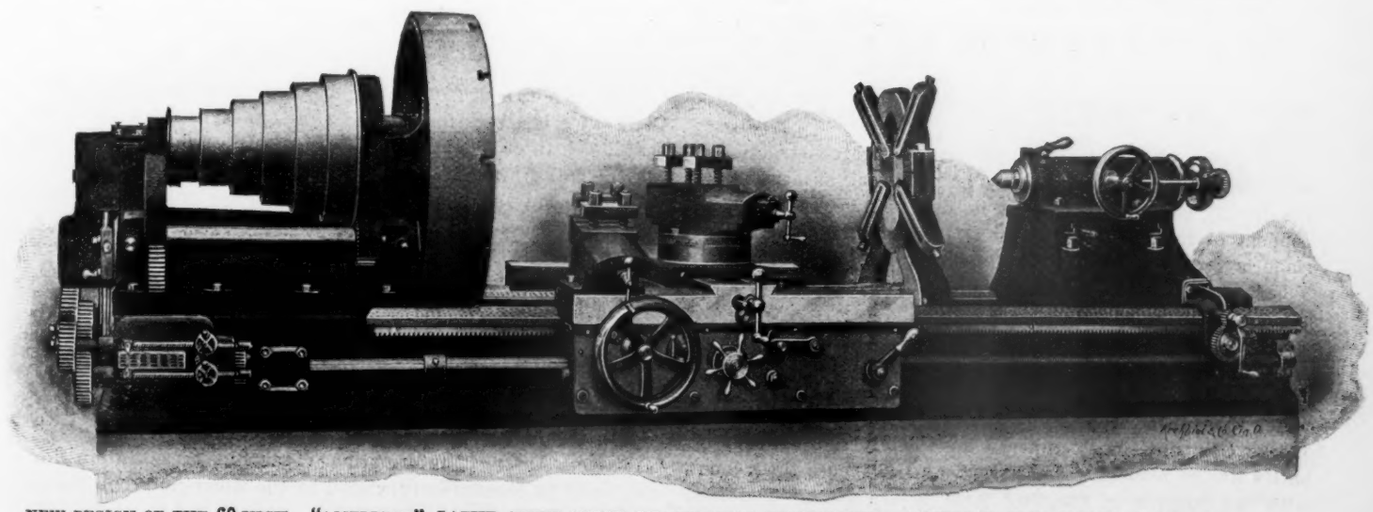
Tanks for 250 gals. of oil and 1,600 gals. of water are carried on the engine. In working order with full tanks of water and oil the engine weighs 106,750 lbs. The drawing was furnished by Mr. G. R. Henderson, formerly superintendent of motive power of the road. In a large shop plant such a crane finds a wide field of usefulness and saves a large amount of manual labor.

NEW 60-INCH LATHE, WITH CHANGE-GEAR MECHANISM, AND A NEW DESIGN OF PLANER.

THE AMERICAN TOOL WORKS COMPANY.

The accompanying engraving is an illustration of the new heavy model of the "American" lathe which has been brought out by the American Tool Works Company, Cincinnati, Ohio. This tool is their 60-in. lathe with improved rapid-change-gear mechanism, which greatly increases its possibilities as a rapid handler of heavy work.

The change-gear mechanism, which is located on the head end of the bed, consists of a clutch device of an entirely new design, through which seven changes for feeding and screw cutting are readily available without the removal of a single



NEW DESIGN OF THE 60-INCH "AMERICAN" LATHE, WITH QUICK CHANGE-GEAR MECHANISM.—AMERICAN TOOL WORKS COMPANY.

gear. Then, by changing one, and only one, gear on the stud, seven additional changes are provided, the quadrant being so designed as to obviate the readjusting of the entire train of gears to each new change gear. Nine change gears are ordinarily furnished, thus providing a total of 63 changes of threads and feeds with the minimum of effort.

Each of these possible changes is indicated on the index plate located on the front of the gear box; by the simple movement of a hand wheel a pointer is brought directly above the desired thread or feed. This will indicate the number of the change gear to be placed on the stud, and also automatically arranges the gears in the gear box for cutting the thread or feed desired. The range of threads is from 1 in 8 ins. to 16 per in., and of feeds, from 1.327 to 170.

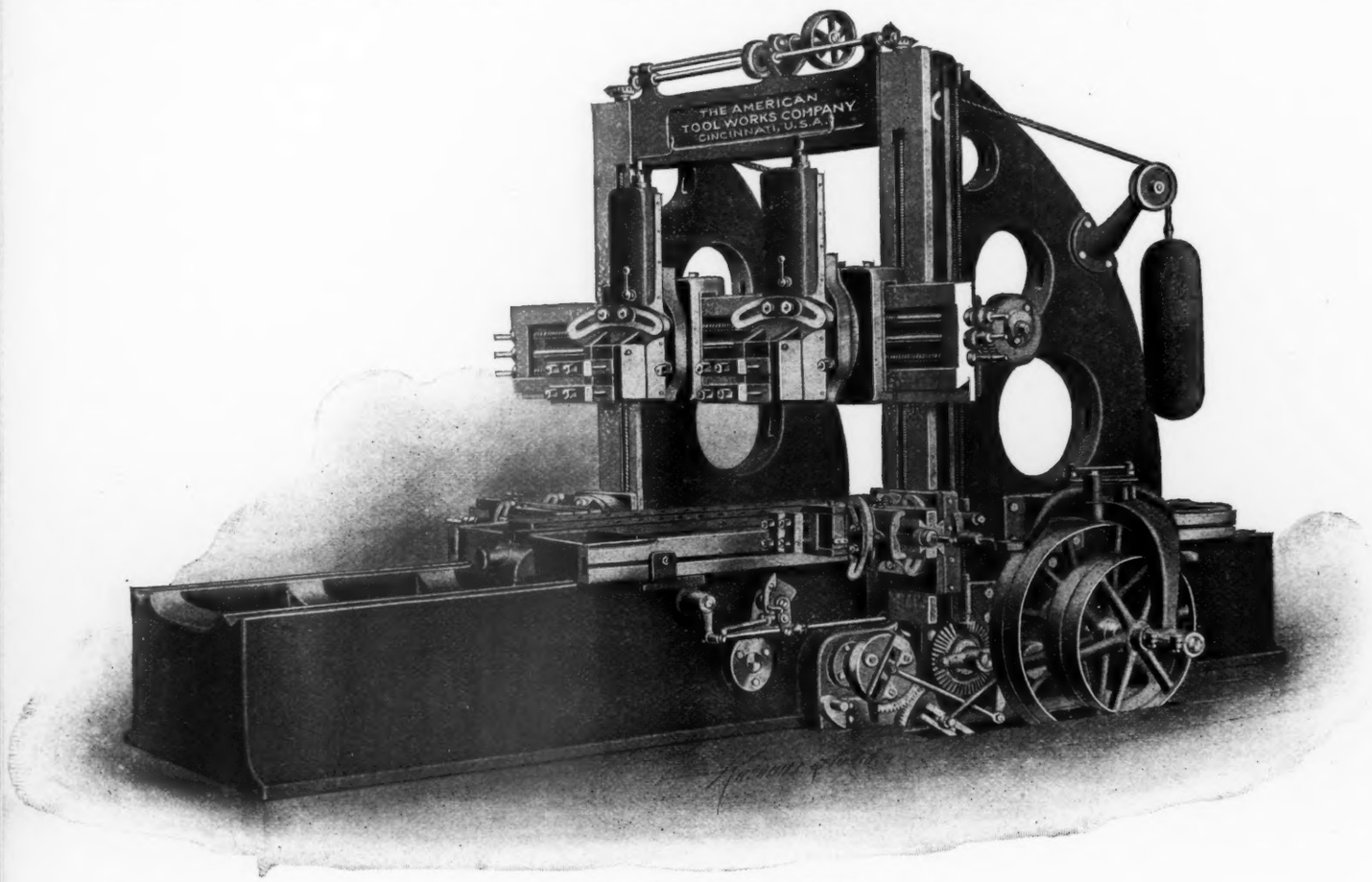
The lathe can be changed for left-hand screw cutting by means of tumbler reverse plate, mounted on the end of the headstock. It is not necessary to interpose an idler gear as formerly, and no gears are disarranged by this improved method.

The bed is of patent drop-V pattern of such construction as to secure the greatest rigidity. The headstock is massive and the driving cone is mounted on its own spindle, entirely independent of the main spindle and is powerfully geared. Carriage is very heavy, especially in the bridge, due to the drop-V bed, and has double apron extending full length. All gears are cut from the solid.

THE NEW 48-INCH PLANER.

The illustration presented on this page shows the new design for the 42 and 48-inch sizes of the "American" planers, which has just been brought out by the American Tool Works Company. This concern have lately redesigned their entire line of planers, from 22 inches to 48 inches throughout, with the purpose of adapting them to the greatly increased duties imposed by the new tool steels and modern shop practice. Every condition influencing modern planer work has been given careful consideration, and as a result, the increased efficiency of their planer, and its adaptability for use with high-speed steels, have placed it at the front as a rapid work producer, by the most progressive methods.

Strength and rigidity have been the foremost aims in the new designs. The bed has been made unusually heavy, extra wide between the V's, and thoroughly braced by heavy box girts at short intervals. The bed is of unusual length in proportion to the table, leaving but little overhang to the table when planing at full length. The table has ample thickness, is provided with improved shifting mechanism, which removes the belt from one pulley before the return movement belt engages the other, thus obviating all disagreeable shrieking of belts. A quick return is provided and reverses are made without shock or jar. The table can be run from under the tool for examination of work, and a safety locking device prevents the table from starting before the operator is ready.



THE NEW DESIGN OF THE 48-INCH AMERICAN PLANER.
THE AMERICAN TOOL WORKS COMPANY.

The housings are of the double-webbed cored-section type, with wide bearings for the cross rail, and are fitted perfectly parallel with each other and square with the table. The heads on the rail are made right and left to permit of planing close together, and the saddles are graduated for angular planing. The feeds are automatic in all directions and can be operated from either side of the machine; the down-feed is of exceptional length and is equipped with a micrometer adjustment. The side heads are of compound-slide type, giving the tool exceptional range of travel, and are counterbalanced and can be run below the level of the table when not in use. All pinions are of steel and all shafts are crucible steel of large diameter, each arranged so as to be readily removed when necessary without disturbing the rest of the machine.

Further detailed information regarding these interesting tools will be cheerfully furnished by the American Tool Works Company.